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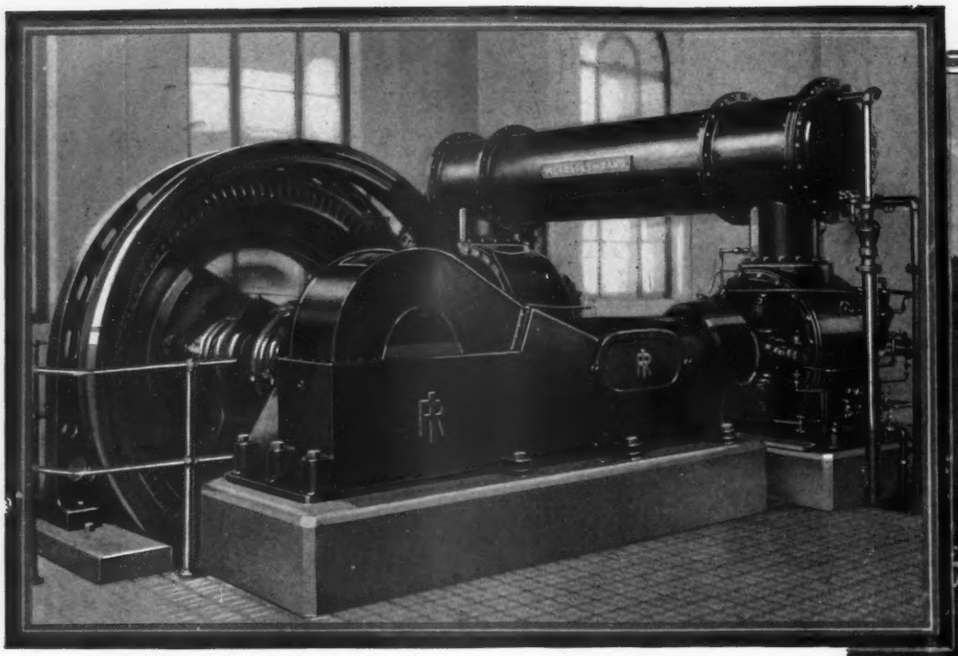
A Gold Property in the Philippines

N'Changa's Ore Possibilities

The Equipment Review



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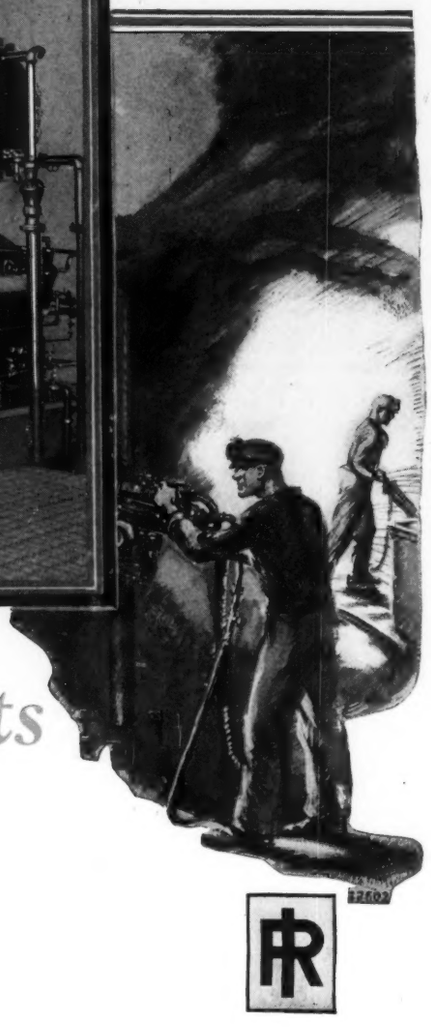

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Contents for December 28, 1929

VOLUME 128, NUMBER 26

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Editorials 989

WHEN IS OPTIMISM WARRANTED in Discussing Ore Reserves? . . . Construction Engineer Should Collaborate With the Geologist . . . Mexico's "Hydraulic" Lead Mine Indicates Uncertainties of Mining . . . New Ideas in Minimizing Effects of Dust Underground . . . Promotion Literature and Good Salesmanship . . . Accident Prevention and the Human Factor.

The Choice of Suitable Electric Trolley Locomotives for Metal-Mine Haulage 992
H. I. ALTSHULER

Slate Mining in Germany 998

Rare Metals Essential to Industry 1001

Lead Slags Investigated at the Furnace Tuyères 1002

Financial Loss Represented by Mine Accidents 1003

Operating a Gold Property in the Philippine Islands 1004
F. M. KURIE

One of Chile Copper's Huge Blasts 1005

Digest of Current Literature 1006

Useful Operating Ideas 1007

Comment and Criticism. 1008
Industrial Progress 1010
Personal Notes 1013
Mining News 1014
Market and Financial News 1020
Indicators of Industrial Activity 1021
Market Report 1022
Mining Stocks 1024
Service Directory 33
Searchlight Section 34
What and Where to Buy 36
Advertising Index 40

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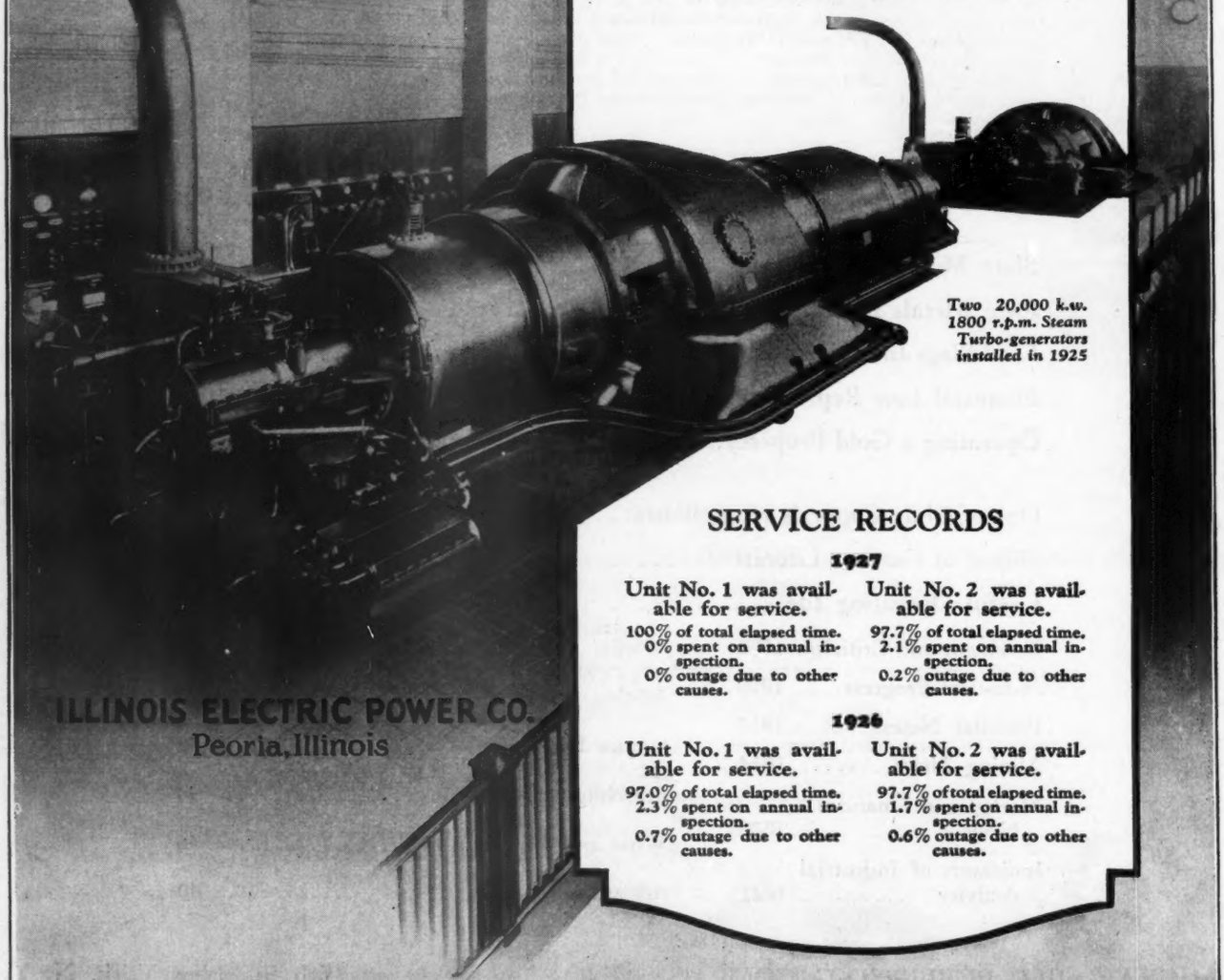

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Unit No. 1 was available for service.	Unit No. 2 was available for service.
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ENGINEERING AND
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When Is Optimism Warranted in Discussing Ore Reserves?

IN HIS presidential address before the Australasian Institute of Mining and Metallurgy, Dr. E. C. Andrews did not hesitate to make predictions regarding mineral resources as yet undiscovered in the Commonwealth. Speaking of china clay, he said it was almost incredible that a country like Australia, three million square miles in area, and abounding in clays, should not possess commercial deposits of material suitable for making high-class porcelain or white china ware. Yet so little developed was the continent, and so little known were its clays, that all one could say at present was that rich china clays in all probability occur there.

Few will accuse Doctor Andrews of being unduly optimistic because of these remarks. Indeed, at the worst, a critic could only say that he had made a reasonably conservative assumption. As in Australia with clay, so in the United States in respect to manganese and certain other minerals that have not been widely exploited. With manganese occurring in many scattered localities, the deposits for the most part undrilled, scarcely explored, and in instances entirely untouched, the assumption a few years ago that the United States contained at least a large tonnage of low-grade ores, or, more conservatively, manganese-bearing materials, was as reasonable as that which Doctor Andrews has made. Yet how pessimistic regarding the possibilities of this mineral resource some engineers then professed to be. The domestic reserve of these low-grade materials was small, they held, and, in contrast with the market demand, negligible. Since attention became focused on manganese, however, the proved tonnage has grown, now by discovery in some new locality, as at Chamberlin, S. D., now by new work in a district already discovered, until today an executive of one of the largest and most conservative mining companies in the United States has no hesitancy in admitting the existence of a reserve sufficient, when beneficiated, to supply the needs of the United States, as now seen, for 50 to 75 years to come.

Sulphur and zinc are also cited by Doctor Andrews. "Forty years ago the Australian supplies of sulphur would have been considered as non-existent," he said. "The need for sulphur in superphosphate manufacture and the desire to be independent of foreign supplies has caused the matter to be regarded differently, and the sulphur fume which may be expected to be won from the roasting of ores . . . will reach a total of many million tons of pure sulphur."

With respect to zinc, Doctor Andrews said: "Only by the skill of the Broken Hill metallurgist was the Commonwealth permitted to recognize its wealth in the mineral zinc." A quarter century hence, perhaps, it shall similarly be said that only by the skill of the metallurgists of various private companies and of the Bureau of Mines was the United States led to perceive a new source of wealth in manganese.

Optimism, at once originating in and restrained by common sense, and going hand in hand with a program of research that is continued even in the face of temporary failure, is a prerequisite to the development of any resource of low-grade mineral. Success in the end will bring more supporters. Hindsight is always superior to foresight. When the objective is once achieved, the ranks of the individuals who saw it coming all along are sure to be greatly swelled. Those desirous of riding on the bandwagon are always more numerous than those willing to foot it along the dusty road.

Construction Engineer Should Collaborate With the Geologist

ABOUT a year ago the board of engineers appointed to investigate the failure of the Lafayette dam, near Oakland, California, reported that, although the immediate cause of failure was overloading by a combination of the weight of the dam and steepness of slopes, the dam would have shown no weakness had it rested on a firm foundation. As pointed out in these columns at that time, the report of the board emphasized the necessity for competent geological investigation of dam sites and foundations.

Evidently the lesson derived from the Lafayette dam failure has borne fruit, for the board of engineers and geologists that examined the San Gabriel dam site recently condemned it as a foundation for a proposed gravity concrete dam. The direct and all-important application of expert geological knowledge in the examination of the site and foundation is clearly apparent in the final report of the board. The forks of the San Gabriel River above the site are said to be at the junction of two fault zones; the crystalline rock complex of the proposed foundation and the immediately adjacent ground is weakened by faults, slips, and crush zones. In addition, the rock surfaces are disintegrated. Pulverized rock along fault breaks is at many points in the form of clayey gouge. A severely broken zone lies beneath the east third of the canyon bottom, where the bedrock channel is deepest. At this level, the east portion of the rock floor of the canyon appears to be less substantial than the west. Better conditions were not found at any other location in the immediate vicinity of the forks. Information gained from test shafts, tunnels, and boreholes did not hold out encouragement that conditions would improve materially with depth.

These findings will, perhaps, attract little general

attention, certainly not even a small fraction of that which the Lafayette dam failure naturally occasioned. But among the engineering fraternity, the board's final report has serious import in that it renders plainly evident the advisability of not only making a geological examination of a site but also of continuing such investigations during excavation operations and until the final preparation of the foundation on which the dam structure is to rest.

Mexico's "Hydraulic" Lead Mine Indicates Uncertainties of Mining

IN 1926, while cutting a station on the No. 8 level, Ahumada Lead struck a large flow of water at its mine in the Los Lamentos district of Chihuahua, Mexico. Until then, this property, originally developed by General G. C. Greenway and Dr. L. D. Ricketts, had proved a bonanza lead mine. From the formation of the company in 1921 until the end of 1925, it had paid dividends equal to one and one-half times its capitalization. Production was at the rate of about sixteen thousand tons of lead and four hundred thousand ounces of silver annually.

But water proved Ahumada's Nemesis. For a time dividends were continued as the company mined orebodies above the water level. Within a year and a half these available orebodies were almost exhausted. Additions were made to the pumping equipment, and the No. 8 level was again made available for production. New development, however, was continually releasing new water. Time and again the operators were driven out of the workings.

The latest word from Ahumada is that a small tonnage of high-grade ore is being extracted from No. 8 level. Production from all sources in the mine is about 1,200,000 pounds of lead per month. And, with its new pumping equipment, the company is handling about 100,000,000 gallons of water per month. In other words, for every pound of lead extracted, almost one hundred gallons of water—weighing about eight hundred pounds—must be pumped out of the workings. And lead is selling at six and a quarter cents per pound! If ever a lead mine deserved the title "hydraulic," Ahumada is the mine. Few producing mines of importance can point to as large a flow of water handled per unit of metal produced.

Dividends on Ahumada's stock have been suspended since 1927. With production but a third of what it was, and the price of lead apparently determined to stay below seven cents, the cost of pumping makes the small net deficit showed each quarter, after depreciation and taxes have been deducted, an outstanding achievement. The company is to be congratulated for its courage in continuing work in the face of such tremendous disabilities.

Nor has the tenacity of the management been unrewarded. With the recently added pumping equipment, the flow of water appears to be under control. Extraction of high-grade ore from No. 8 level and the finding of several small rich orebodies on upper levels have improved the situation. Generally speaking, it is better at the end of 1929 than at the end of 1928. This improvement is reflected in the last quarterly statement, which shows a net loss of $32,000 after all charges, including depreciation, in the first nine months of the year, as compared with a similar loss of $118,000 for the corresponding period of 1928.

Ahumada's plight should serve as another reminder of the vast difference between mining and manufacturing industries. Particularly when a mining company derives all its revenue from a single mine or a single group of mines, the uncertain must always be the expected. Precisely this element of chance is what has given the mining industry its glamor. But carping critics, who talk of inordinate profits when they notice that, say, Miami Copper is now paying eighty per cent annually on its original capitalization, are prone to forget the uncertainties. *Engineering and Mining Journal* feels that as long as mines are operated by individual capitalists in a community that is committed to the capitalist doctrine, the mining industry is entitled to a much greater return on its capital investment than the ordinary manufacturing enterprise.

New Ideas in Minimizing Effects of Dust Underground

WET METHODS for reducing the amount of suspended dust in mine air have received general recognition, and experience is now sufficient to judge the merits and objections that may be traced to the practice. The most obvious objection is the fact that humidity is increased to the saturation point. If temperatures are high, this results in difficult operating conditions. Dr. J. S. Haldane has made this important observation: "I was from the first keenly in favor of wet methods, and, like many others, thought that they would so reduce dust inhalation as to abolish the dust danger entirely. Experience, however, has not borne out this anticipation, for there is still a good deal of silicosis after long exposure, in spite of all the watering and all precautions." He states that no reasons seem to exist for suspecting that tuberculous infection occurs more readily under wet conditions. Likewise, wet conditions make ankylostomiasis infection—a form of hookworm disease—easily possible, unless rigorous precautions are taken.

Much attention has been directed in South African gold mines to the maintenance of safe and hygienic conditions underground. Major effort was directed toward reducing dust suspension to a minimum, and this has been successful by the enforcement of rigid inspection. But, as one problem appears to be solved, others arise.

Doctor Haldane proposes the use, if necessary, of a harmless diluent dust in stopes and drives, in place of water. Research has shown that some rock dusts do not produce harmful effects when inhaled in considerable quantities over long periods. He ascribes the protective effects to the amorphous substance in the rock, as contrasted with crystalline minerals, and proposes to allow shafts, inclines, and open levels to remain dry and treated with the added dust. Efficient dust-collecting methods will be used with drills, even where water is employed. A sufficient quantity of diluting dust should be released into the air after each shot or round of shots.

The ideas advanced are novel. Difficulties are appar-

ent. Doctor Haldane admits that the theory that diluent dust abolishes or greatly reduces the danger from silica dust is obscure, adding that there is always a limit to the amount of dust that can be inhaled without harm of some kind. Nevertheless, an interesting point has been raised, and opportunity is available for research. If changes can be introduced that will obviate the general use of water in deep mines for dust prevention, and at the same time reduce the tendency to tuberculous infection, an improvement over present conditions will result, and the mining industry will have armed itself with additional methods for coping with a troublesome and difficult problem.

Promotion Literature and Good Salesmanship

PROMOTION of a mining property, or the raising of capital by selling stock to provide the wherewithal for exploration, development, and operation, is recognized as a necessary procedure. It is a form of selling. Unfortunately, much of the promotion literature broadcast is characterized by extravagant statement, by promises of future wealth or of dividends in generous amount. Most prevailing opinion appears to hold that a mining stock will sell better if the prospectus has this aura of exaggeration. Few specific facts are given. Seldom is attempt made to give information on the character and competence of the men who are to control the destinies of the company. The prospectus makes no favorable impression on the experienced in mining, or on others who might seek carefully to study the statements and discover therein justification for entertaining an interest in the project.

Vague or meaningless statements are made. In a promotion leaflet recently called to the attention of *Engineering and Mining Journal* appears the statement that "Silver appears in several places on our ground. Gold assays range from a trace to $600 a ton. Silver assays up to 102 ounces. Copper from 142 to 324 pounds to the ton of ore. Lead occurs in both silver and copper veins." Elsewhere the promoter maintains that "Placed end to end the claims we hold would extend nearly eight miles." Fear of legal difficulties entertained by the would-be stock buyer is removed by the statement that "Apex controversies are impossible as we own from valley up to tops of highest mountains included in this mineralized zone." The clinching sales argument is as follows: "The opportune time for securing stock in copper properties is before shares have commenced to soar in price. For example, if one waits until stock is $100 a share and buys a share, then, a dividend of one dollar a share means but one dollar on the investment. If he buys at one dollar a share he gets 100 shares for his $100 and from a one dollar a share dividend realizes $100."

Within the leaflet quoted can be found no essential information about the property. In fact, it would tempt no ordinarily careful person to part with money. Even if the property has merit, a prospectus of this character may be expected to discourage further inquiry by those of any intelligence. To interpret the method in the most charitable light, it indicates poor salesmanship.

Accident Prevention and the Human Factor

SPEAKING at a recent meeting of the National Safety Council, Mr. William C. Bochert, safety engineer for the St. Joseph Lead Company, stressed the importance of considering the human factor in the prevention of accidents. In organizing the accident-prevention activities of this company, extensive and profitable use was made of statistics, which indicated that any safety campaign, to be effective and to accomplish the results desired, must involve more than the provision of mechanical safeguards. An analysis showed that less than 15 per cent of the accidents occurring on company properties, over a period of several years, could have been prevented by adequate and improved mechanical safeguards.

The foundation for the effective safety work in the St. Joseph Lead organization was laid, according to Mr. Bochert, in the inauguration of a liberal pension plan for its employees. Associated with this pension plan is the company's group insurance plan, which gives each man $500 free insurance after he has been in the steady employ of the company for six months. This amount is increased, up to a maximum of $2,000 when the man has remained with the company ten years or more. In addition, the company's insurance plan makes it possible for each employee to buy additional insurance to the value of $2,000 at a nominal yearly rate. The company has also provided good housing facilities, an ample supply of pure water, healthful recreational advantages, and has sponsored other community activities that have made the Missouri lead belt an ideal mining community.

These advantages, sponsored and provided by the company, have been appreciated by the employees, a fact that is demonstrated by Mr. Bochert in low labor turnover figures. In 1919, for example, before some of these measures had become effective, 4,846 men severed their connections with the company. To obtain a percentage figure for a year, the number of separations is divided by the number of men on the payroll. The figure obtained for 1919 was 233 per cent. In 1920 it was 260 per cent, in 1921, 212 per cent; in 1928 it was 22 per cent. In other words, out of 3,000 employees in 1928, only 666 separations from the payroll occurred. The conclusion is inescapable that low labor turnover is conducive to more effective safety work.

Henceforth, *Engineering and Mining Journal* will appear in enlarged form at semi-monthly intervals. The next issue will bear the January 9 dateline; the second issue of the month, January 23.

The first issue of *Metal and Mineral Markets*, with the standard *E.&M.J.* price quotations, market comment, statistics, and general information for the buyer and seller of metals, minerals, and ores, will be mailed a few hours after the closing of the market on Wednesday of each week, except when Wednesday is a holiday, in which case the forms will be closed on the Tuesday evening preceding. The first issue of *Metal and Mineral Markets* will therefore go to press on New Year's eve.

The sixty-first annual review number of *Engineering and Mining Journal* will appear early in February.

The Choice of Suitable

Electric Trolley Locomotives

for Metal-Mine Haulage

H. I. ALTSHULER

Consulting engineer, Cia. de Real del Monte y Pachuca
Pachuca, Hgo., Mexico

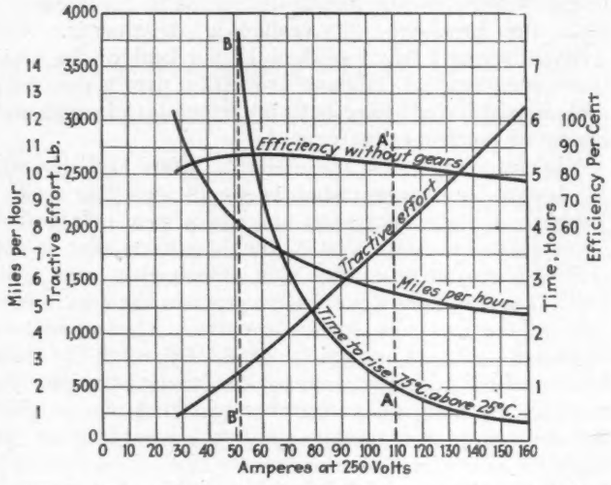

Miles per Hour
Tractive Effort, Lb.
Time, Hours
Efficiency Per Cent
Amperes at 250 Volts
Efficiency without gears
Tractive effort
Miles per hour
Time to rise 75°C. above 25°C.
A
A'
B
B'
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14
1 2 3 4 5 6 7
60 70 80 90 100

Fig. 1—Characteristic curves on 250-volt motor. Composite curves made from characteristics of three separate sets of curves on motors rated at 30 hp. each.

TROLLEY LOCOMOTIVES are easily adaptable to varying haulage requirements underground. For this reason many installations are made without sufficient consideration of the duty to which the machine is to be applied. Mine superintendents and managers are seldom familiar with the engineering practice used by electric-railway engineers, and upon consulting their handbooks will find that electric-railway problems involve many details not applicable to underground haulage; at least factors are involved that are not of importance in the selection of a mine locomotive. For this reason, locomotives may be ordered following a sales recommendation which may not have taken all the important factors into consideration, or which may not have submitted the best machine available to perform the given duty. The following discussion is not to describe the advancement in trolley-locomotive design but to give the essentials to be considered in choosing the size of a machine to perform a given duty.

As the narrow gage commonly used in mines frequently limits the size of motor that can be used in the locomotive, it is of vital importance in the selection of a locomotive that motor heating be investigated. The usual method of calculating the tractive effort required to move the loaded train on the most unfavorable section of the run, and selection of a machine with that rating, is insufficient. Most locomotives have a rated drawbar pull (d.b.p. = tractive effort less force required to move the locomotive itself) equivalent to 25 per cent of its weight.[1] This tells absolutely nothing of motor capacity.

The manufacturer will often give the locomotive's drawbar pull and amperage requirement without further explanation. This rating is usually in accordance with the specifications of the American Electric Railways Association, which requires that electric locomotives be rated for one hour's continuous service to give a 75 deg. C. temperature rise.[2] Obviously, this does not fit many metal-mining conditions, since street railways are continually starting and stopping, whereas in metal mining one is often fairly continuous operation.

Applying the simplest effective method to a problem of fairly continuous haulage, one should determine first the maximum tractive effort required on the most severe section of the run, and then the equivalent continuous current required for the complete cycle with a given locomotive. If this falls within the continuous-current capacity of that locomotive, the choice is safe and the danger of frequent armature trouble is eliminated. To make these calculations, the characteristic curves for the motors used in the locomotives must be used. Manufacturers do not always submit complete characteristics for their machines, but the purchaser has the right to require complete specifications of the machine he intends to buy, and usually can obtain them.

Locomotive Characteristic Curves

Fig. 1 shows a typical characteristic curve for a direct-current motor used in an ordinary mine locomotive. Two motors are usually used in each locomotive, though mine locomotives are sometimes equipped with only one and sometimes with three motors. The curves do not represent any particular motor, but were constructed from curves of motors built by three leading locomotive manufacturers. In each case the motor whose characteristics were used is one with a 30-hp. rating. There are two of these motors in one 6-ton locomotive in each instance. Amperes are always plotted as the abscissas, and the other functions plotted as ordinates against amperes.

The temperature curve is necessary to determine the motor rating. The point *A* in Fig. 1 is the usual rating of the machine. This is where the one-hour ordinate strikes the temperature curve, so in following the *A-A'* line the amperes (per motor), speed, tractive effort (per motor), and efficiency are obtained for the one-hour basis. The point *B* in Fig. 1 gives the same information for

The second of a series of articles on the electrification of mining and metallurgical operations, the first of which, on "Electrification at Chuquicamata," appeared in the issue of Dec. 21.

[1] Equivalent to 25 per cent adhesion for cast-steel tires without sand, and to 20 per cent adhesion for chilled cast-iron wheels without sand.

[2] Degrees centigrade used throughout.

continuous operation. This point is determined by the vertical trend of the temperature-rise curve. The 75 deg. temperature rise over 25 deg. ambient temperature marks the safe limits within which the machine can operate. The tractive effort curve in conjunction with the speed curve will enable one to determine the time required by the locomotive to traverse each section of the run with a given load. Moreover, for the given tractive effort on each section of the run, the amperes required can be taken from the characteristic curve. Some manufacturers submit curves showing drawbar pull instead of tractive effort. Consequently, when applying such curves it is not necessary to take into account the force required to move the locomotive itself on the various sections of the run. The efficiency curve is useful for determining the locomotive's horsepower rating. This point will be discussed later. Some manufacturers give the efficiency curves with gears and others without gears. As a rule the loss in single reduction gearing is about 5 per cent.

Typical Haulage Example

Let us assume the following conditions as a typical haulage problem in a metal mine:

Short tons to be hauled in two shifts, seven hours—effective work per shift	700
Tons—ore capacity each loaded car	4
Weight of empty car, roller bearing equipped, lb	5,000
Loading time required per car, minute	1
Unloading time required, per car, minute	½
Switching time required on each end of haul, minutes	5

The run is 3,500 ft. long divided as follows:

	Ft.
From loading point, level track	550
Grade of 0.6% in favor of load	1,000
Grade of 0.2% against the load	1,050
Grade of 0.4% against the load	400
Level track to unloading station	500
Total	3,500

It will now be assumed that one 6-ton locomotive carrying two motors with characteristics such as shown in Fig. 1 has been proposed for the job, or that such a locomotive is available. To ascertain whether the machine will do the required work, one must determine the heaviest load that the locomotive will haul on the most unfavorable section of the run, determine if the locomotive will be able to stop this load on the steepest part of the run, and then determine whether the locomotive, within the limitations obtained by the first study, will haul a load sufficient to give the desired tonnage without overheating.

Tractive Effort Calculations

Fundamentally, a locomotive is a machine used to place a load in motion or bring a load to rest. If we consider a locomotive attached to a train and at rest on any given grade, the static conditions may be expressed as:

Force exerted as pull through drawbar of locomotive to move load on up grade $= W(R + G)$ (1)

Force exerted as push through drawbar of locomotive to hold train on a given grade $= W(R + G)$ (2)

Where W = weight of load in tons.
R = rolling resistance in pounds per ton.
G = grade resistance in pounds per ton (1% grade adds 20 pounds per ton to grade resistance).

Obviously, formula (2) need be considered only in problems where the down grade resistance ($-G$) becomes greater than R. Under such conditions the train would roll under its own weight. In the foregoing formulas the weight of the locomotive × the per cent adhesion is the force which the locomotive is capable of exerting in either case, so the formula becomes, using 25 per cent adhesion:

$$0.25 \times 2{,}000 \times L - L(R_1 + G) = W(R + G) \quad (3)$$

$$L = W\frac{(R + G)}{500 - (R_1 + G)} \quad (4)$$

Where L = weight of locomotive in tons.
R_1 = roller resistance of locomotive.

If we assume that the service is to be over a track with numerous though not excessive curves, we will take a tractive resistance of 30 lb. per ton for the trail load and 20 lb. per ton for the locomotive, on level track. Values for tractive resistance vary widely, and for some roller-bearing cars a figure as low as 10 lb. per ton has been given on clean, dry, straight level track. In mine work, however, this figure is seldom less than 20 lb. on a reasonably straight level track. When a number of curves are present it is much safer to use 30 lb. per ton.[3]

Under the assumed conditions the heaviest pull on the locomotive occurs when the loaded train is on the 0.4 per cent grade against the load. Using 25 per cent adhesion we may substitute in formula (4):

$$W = 6 \times \frac{500 - (20 + 8)}{30 + 8} = 74 \text{ tons.}$$

Each loaded car weighs 6½ tons, so $\frac{74}{6\frac{1}{2}}$, or eleven cars, will be the maximum that the locomotive can haul on the most unfavorable grade on the run (disregarding fractions of a car).

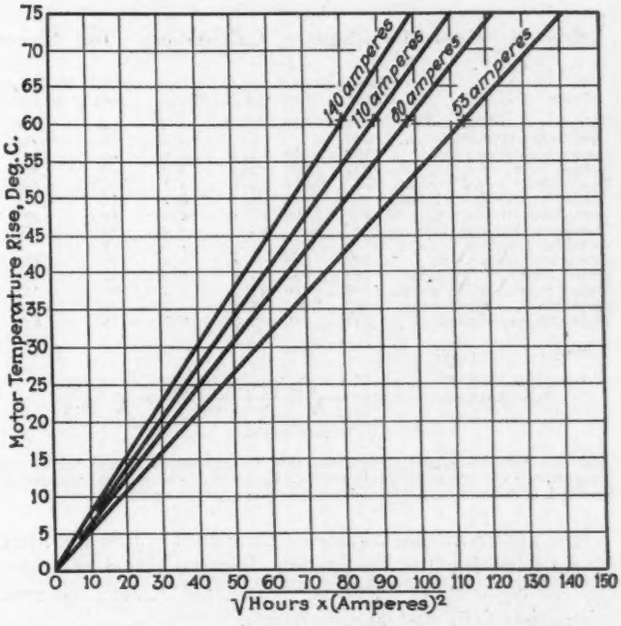


Fig. 2—Construction curve for obtaining values of time for any temperature rise, at given amperage. For 250-volt motor, characteristics are as of Fig. 1.

It is apparent that under none of the conditions given in this example does G exceed R; therefore the locomotive weight is not involved to hold the train on the steepest section of the run.

Motor Heating Calculation

In the foregoing calculation we have taken the tractive effort of the locomotive to be 3,000 lb.—that is, 25 per cent of its weight. That means that the locomotive will be able to exert this force without slipping the wheels. Referring to Fig. 1, it appears that with a tractive effort of 1,500 lb. per motor (3,000 lb. for the two motors in the locomotive), the motor would reach the limiting safe temperature in less than 1¾ hours of continuous duty.

[3]Curves are calculated for railroads by using 0.5 to 1.0 lb. per ton increased tractive resistance per degree of curvature for the length of train on the curve, but for mine use we have smaller wheel-base figures, narrower track gage, and non-rigid wheels on axles which reduce the allowance considerably. See Mine Car Friction, by M. D. Hersey and others, Bulletins 13 and 20, Carnegie Institute of Technology, Pittsburgh, Pa., 1924 and 1925.

As we cannot work the locomotive continuously at its maximum capacity, we will assume for our first approximation that fewer than eleven cars are hauled per trip; arbitrarily, we may try a calculation with nine cars. If this results in overheating, a calculation must be made with fewer cars. If a considerable margin results from our calculations, we may calculate the problem on the basis of ten cars per trip.

Weight of nine loaded cars = 58½ tons.
Weight of nine empty cars = 22½ tons.

	Level Track	+0.2% Grade	+0.4% Grade	—0.6% Grade
Tractive effort loaded train on	1,875	2,133	2,391	1,101
Tractive effort empty train on	775	681	567	1,137
Speed, miles per hour loaded train (a)	7.1	6.8	6.5	8.6
Speed, miles per hour empty (a)	9.8	10.4	11.0	8.5

(a) From characteristics, Fig. 1. Use half the tractive effort values for locomotive to get values per motor.

From the foregoing calculations we are prepared to make our root-mean-square current tabulation which will answer the question on motor heating. If the square root of all current consumption during the cycle is under the continuous current capacity of the motors, we are within safe limits.

Table II—Root-Mean-Square Calculations[a] for Motor

Cycle	Tractive Effort	Distance, Ft.	M.p.h.	Time	Current	(Current)² × (Time)
Switching (½ switching time)	0	....	....	1.3	0	0
Loading (½ loading time)	937	....	....	4.5	66	19,700
Loaded train level track	937	550	7.1	0.9	66	3,940
Loaded train — 0.6% grade	550	1,000	8.6	1.3	47	2,880
Loaded train + 0.2% grade	1,067	1,050	6.8	1.7	72	8,880
Loaded train + 0.4% grade	1,196	400	6.5	0.7	78	4,280
Loaded train level track	937	500	7.1	0.8	66	3,500
Unloading (½ unload time)	387	.....	....	3.4	38	4,950
Switching (½ switching time)	0	.....	....	1.3	0	0
Empty train level track	387	500	9.8	0.6	38	874
Empty train — 0.4% grade	283	400	11.0	0.4	32	413
Empty train — 0.2% grade	340	1,050	10.4	1.1	35	1,352
Empty train + 0.6% grade	569	1,000	8.5	1.3	48	3,020
Empty train level track	387	550	9.8	0.7	38	1,016
Total		7,000		20.0		54,805

$$\text{Root-mean-square current} = \sqrt{\frac{\Sigma\,(\text{current})^2 \times \text{time}}{\text{total time}}} = \sqrt{\frac{54{,}805}{20.0}}$$

= 52 amperes.

(a) A root-mean-square (abreviated R.M.S.) calculation means taking the square root of the sum of the products of the square of all values × the time period for which each value is operative divided by the total time period.

It is apparent that a train of nine cars is just the limit of capacity for the locomotive, because the continuous current capacity is 52 amperes and the R.M.S. current calculation falls just at this figure.

The calculations have been obtained in the following manner: The tractive resistances in Table I are obtained as follows: For tractive effort of loaded train on + 0.2 per cent grade: Grade is against load, so tractive effort for trail load is (30 + 4) lb. per ton, and (20 + 4) lb. per ton for the locomotive. Trail load is 58½ tons, and locomotive is 6 tons; therefore, $58\frac{1}{2} \times 34 + 6 \times 24 = 2{,}133$ lb. tractive effort for train on this section. The others are obtained similarly. In Table II one-half of these tractive efforts are carried over to the first column, because in that table we are dealing with one motor only. For loading, it is assumed that the tractive effort is equal to that required on level track with the loaded train for half the time of the loading period. Similarly, for unloading it is assumed that the tractive effort is equal to that required to move the empty train on a level track for half the time of the unloading period. Switching is considered as not requiring current, because the motors should be cooling at one quarter of the full time while running unloaded. The time required for each section of the cycle is determined as follows: The miles-per-hour under a given tractive effort is obtained from the characteristics, Fig. 1. As feet per minute $= \frac{5{,}280 \times (\text{miles per hour})}{60} = 88 \times$ miles per hour, and as the distance on each section of the run D, is known, we may substitute in this formula:

$$\text{minutes} = \frac{D}{m.p.h. \times 88}$$

In the case of the loaded train on the level track for the distance of 550 ft., we get 7.1 m.p.h. for the tractive effort of 937 lb. from the characteristics. Then,

$$\text{minutes on this section} = \frac{550}{7.1 \times 88} = 0.9 \text{ minute.}$$

The current required per motor on each section is taken directly from the characteristics for each tractive effort. It now remains to be seen if the maximum train will give the desired tonnage. The total time per trip will be taken as follows:

	Minutes
Running time, from Table II	9.5
Loading time	9.0
Unloading time	6.8
Switching time	10.0
Lost time and delays (assumed)	6.7
Total	42.0

Each shift of seven hours (420 minutes) will deliver $\frac{420}{42}$, or ten trips. Each trip delivers nine cars at 4 tons each, so that the tonnage per shift will be:

$$9 \times 4 \times 10 = 360 \text{ tons}$$

The locomotive will give the desired tonnage of 700 tons in two shifts.

Altitude and Ambient Temperature Effect

The characteristics of locomotives as submitted by manufacturers are obtained from tests made at sea level. If the locomotive is to be used at an altitude exceeding 1,000 meters above sea level, the characteristics for permissible motor heating at sea level must be corrected. The Standardization Rules of the A.I.E.E. give the following:

"For machinery operating at an altitude of 1,000 meters or less, a test at any altitude less than 1,000 meters is satisfactory, and no correction shall be applied to the observed temperatures. Machines intended for operation at higher altitudes shall be regarded as special. It is recommended that when a machine is intended for service at altitudes above 1,000 meters (3,300 ft.) the permissible temperature rise at sea level, until more nearly accurate information is available, shall be reduced by 1 per cent for each 100 meters (330 ft.) by which the altitude exceeds 1,000 meters."

This means that the 75 deg. temperature rise curve for sea level must be substituted by another for sea level which will be equivalent to a 75 deg. temperature rise at the altitude where the machine will operate. For example, assume the locomotive for service at 2,000 meters' altitude. The correction is:

$$\frac{2{,}000 - 1{,}000}{100}, \text{ or } 10\%$$

Applying this to the 75 deg. rise, we see that 75—7.5, or 67½ deg. is the temperature rise curve at sea level which will give 75 deg. temperature rise at 2,000 meters above sea level.

If the locomotive is to operate at a higher ambient temperature than 25 deg. a similar correction is necessary on the motor-heating curve. If this is not made, the 75 deg. rise will cause the ultimate temperature of the hottest spot to exceed 100 deg., which would destroy the

insulation of the machine. For example, if the locomotive is to work in an ambient temperature of 32 deg., which is 7 deg. higher than the nominal 25 deg. ambient, a curve showing permissible temperature rise for (75—7), or 68 deg., is the one to be used in determining the locomotive rating at the 32 deg. ambient temperature.

If the locomotive is to be employed at an altitude exceeding 1,000 meters as well as an ambient temperature exceeding 25 deg., a double correction is needed applying first the altitude and then the permissible temperature correction. In the foregoing examples, if the locomotive is to operate at both 2,000-meter altitude and 32 deg. ambient temperature, the temperature-rise curve desired under test conditions at sea level is 60½, or (75—7.5) for altitude—7 deg. (for ambient temperature).

By using these corrections, the temperature rise curve for sea level giving the permissible rise for the local conditions can be determined. The manufacturer should be requested to submit the curve for that rise. If the manufacturer has not tested the machine in question sufficiently to submit the curve for the temperature rise desired, or if an approximation is desired before the information can be secured, it is possible to construct a theoretical curve for varying temperature rises, having the curve for 75 deg. rise at sea level as a basis. As heating varies directly as the square of the current over the time applied, we may plot a curve with temperature rise as ordinates and the square root of (current)^2 × time effective as abscissæ which will be a straight-line function for a constant current. By using the information on Fig. 1 from the 75-deg. temperature-rise curve, Fig. 2 is constructed for a few values of current. Let us assume that the locomotive used in the previous example is to operate at 2,000 meters' altitude and 32 deg. ambient temperature. It will then be necessary to obtain the temperature-rise curve for 60½-deg. sea-level test at 25-deg. ambient. The details of the construction of Fig. 2 are as follows:

(*a*) From Fig. 1 we obtain a 75 deg. rise for 140 amp. in 0.5 hour.

(*b*) The function $\sqrt{\text{hours} \times \text{amp.}^2}$ then becomes $\sqrt{0.5 \times 140^2}$, or 99.3.

(*c*) 99.3 is plotted against 75-deg. motor temperature-rise and a straight line drawn from this point through zero.

Curves for other values of amperage—that is, 110, 80, and 53—are plotted in the same manner. These values are taken at random. The reverse of this process is used to determine points in order to plot the curve "time to rise 60.5 deg. C. above 25 deg. C.," as shown on Fig. 3. The details of this construction are as follows:

(*a*) From Fig. 2 we pick the intersection of the 60.5 deg. rise and the 140-amp. curve, which gives a value of 80 for $\sqrt{\text{hours} \times \text{amp.}^2}$

(*b*) Therefore,

$$\text{hours} = \frac{80^2}{\text{amp.}^2} = \frac{80^2}{140^2} = 0.32$$

(*c*) 0.32 hour against 140 amp. are plotted on Fig. 3 for the 60.5 deg. temperature-rise curve.

Other points on this curve are obtained in the same manner and the curve is sketched in from them.

It will now be observed that the continuous rating of this locomotive for operation at 2,000 meters' altitude and 32 deg. ambient temperature has dropped to 42 amp. from 52 amp. at sea level and 25-deg. ambient temperature. If we are considering the same haulage example given as typical, for this new altitude and temperature condition, we see that the locomotive considered is insufficient to do the work. The root-mean-square current required in that example is 52 amp. and this new curve shows that the motors would overheat in four or five hours under the same haulage scheme at 2,000 meters' altitude and 32-deg. ambient temperature. Means for overcoming such difficulty will now be discussed.

Motors are rated on their ability to dispel heat. If means were provided to keep a motor cool, its rating or current-carrying capacity would increase greatly. Within practical limits, blowers, provided with suitable air ducts to the motors, have been found satisfactory means for increasing motor ratings. Mine locomotives are often provided with small Sirocco fans to improve their current-carrying capacities. This is by far the cheapest method of obtaining higher ratings for locomotives. Although blowers are the least expensive means of increasing the continuous capacity of locomotives, they should not be used where the haulageways are dusty. Blowers are objectionable in dusty mines, as the dust is blown into the bearings and wearing parts of the locomotive.

The continuous amperage ratings of locomotives can be increased from 33⅓ per cent to 50 per cent by the use of blowers, depending on the type of motor used and its adaptability to forced ventilation. Some manufacturers claim that the continuous-current capacity can be increased 100 per cent by blowing, but that so high a percentage could be obtained in practice is doubtful.

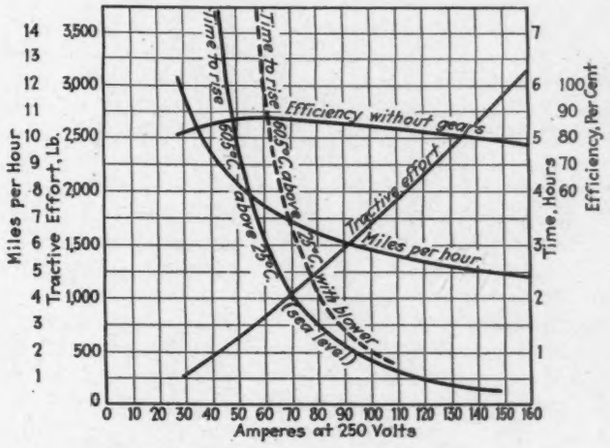


Fig. 3—Characteristic curves on 250-volt motor, the same as Fig. 1. For operation at 2,000 meters' altitude and 32 deg. C. ambient temperature.

The temperature-rise curve for a motor with blower is the only characteristic affected by blowing. The new curve for temperature rise with a motor blown is constructed by increasing the one-hour rating 5 per cent and the continuous rating 33⅓ per cent (or 50 per cent if the larger value is more probable) and sketching the curve between them. Fig. 3 shows this curve and was constructed from the temperature-rise curve used in the previous example, by increasing the one-hour rating 5 per cent:

$$95 + 0.05 \times 95 = 99.75 \text{ amp.}$$

and increasing the continuous rating 33⅓ per cent:

$$42 + 0.333 \times 42 = 56 \text{ amp.}$$

Although the locomotive unblown as used in the example will give the tonnage specified working at sea level and at 25 deg. ambient temperature, it is necessary to equip the motors with blowers to obtain the same results at 2,000 meters' altitude and 32-deg. ambient temperature.

It is often desirable to test mine locomotives to determine whether they are performing up to their ratings. Equipment necessary for a thorough test is: one voltmeter, one ammeter for each motor, one thermometer for

each motor, one dynamometer, and two stop watches. The voltmeter should be connected across the main leads to the controller; the ammeters, in the motor circuits. The thermometer may be inserted between the armature and field coils when the locomotive is standing and the motor uncovered. When temperatures are taken in this manner, 15 deg. is usually added to the reading in order to get the temperature of the hottest spot. If it is possible to insert the thermometer between the armature coils and pack it in with putty, an addition of 5 deg. to get the temperature in the hottest spot is sufficient. Thermometer readings must be taken before the thermometer is removed, as the mercury drops very rapidly

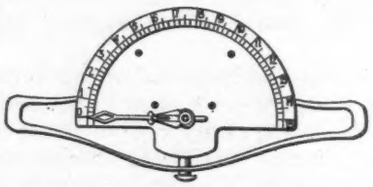


Fig. 4—The Chatillon dynamometer, with extra-loose pointer, which remains at maximum strain after the load is released

after removal. Dynamometers suitable for locomotive testing might be secured through locomotive-manufacturing companies (see Fig. 4). If one is available that has not a large enough range to record the maximum drawbar pull, a lever arrangement must be made whereby the readings can be reduced to $\frac{1}{2}$, $\frac{1}{3}$, or a smaller ratio if so desired. The pointer on the dynamometer dial will fluctuate rapidly between wide limits during the test, so it is necessary for one man to read the instruments as closely as possible at regular time intervals during the test, in order to get an average reading for each section of the run. Stop watches are used to get the time consumed during each period of the cycle.

Usually the object of testing is to determine if the locomotive is delivering its theoretical duty, and, if not, to ascertain the difficulty. Thermometers and a watch are all the necessary equipment for the first part of the test. After calculating the capacity of the locomotive as outlined in the example given, the machine may be put into service with the load as calculated. The trips may be timed and the temperature of the motors recorded every hour. If the temperature rises rapidly, the readings should be taken more frequently. The motors must not exceed the maximum temperature recommended (usually 100 deg. in the hottest spot). If the locomotive pulls this load for a shift without exceeding the allowable temperature rise, and makes the trips in the time as calculated, there is no practical need for additional testing. However, should the allowable temperature rise be exceeded before the shift is completed, the reason may be that the duty is more severe than allowed for in the calculations or that the locomotive may not be performing up to its rating. Further testing is then required. The number of cars should be reduced to the greatest number that the locomotive will haul continuously without overheating.

The problem now is to discover experimentally how much work is being delivered by the locomotive with this load. Voltmeter and ammeter should be connected to the locomotive through the controller connections, the dynamometer being connected between the locomotive and first car. The train with the maximum load as determined previously should be hauled over the run, and readings of all instruments taken for each section of the run, the time consumed on each section to be recorded with the stop watches. As it is difficult to read the dynamometer during such a test, the run should be repeated until checks of these readings, averaged for each section of the run, are obtained. A root-mean-square calculation should be made, using the current and time readings obtained during the test. If the root-mean-square current on the test compares favorably with that as theoretically calculated, the motor rating can be considered correct.

A study of the voltages should be made to see if there has been an excessive voltage drop on any section of the run which would require heavy currents for a longer period than allowed in the theoretical calculations. As a series motor slows down almost in direct proportion to the voltage drop, a large voltage drop would cause the train to move more slowly over the section in which that drop occurred. Insufficient or broken bonding might cause such a drop. The trolley and track circuit should have sufficient conductivity to prevent a greater than 30 per cent voltage drop while running with the controller on the full-speed position. If it does not, a feeder circuit should be installed.

The tractive effort exerted by the locomotive on each section of the run is obtained by adding the tractive resistance of the locomotive to the drawbar pull as obtained by the dynamometer. This tractive effort for the values of current read on each section of the run should be checked against the tractive-effort curve on the locomotive characteristics. The speed curve, against amperes, can be checked by the speed as timed and the ammeter readings on those sections of the run where full voltage was impressed.

As a rule a study of the results of such a test will reveal one of the following causes for the discrepancy between the theoretical and actual capacity of the locomotive.

(*a*) Greater tractive resistance of trail load than calculated.
(*b*) Voltage drop too great on heavy-duty sections.
(*c*) Errors in locomotive characteristics as submitted by the manufacturer.

Reason (*a*) is most frequently encountered on account of dirty track, improper lubrication, improper car bearings, or too many heavy curves on line. Reason (*b*) has already been discussed, and reason (*c*), though not common with responsible manufacturers, may occur.

Refinements of Calculations

The methods outlined in this paper will give results which closely approximate those obtained by more complex calculation. Items of minor importance in mine locomotive calculations have not been discussed. Those which might require attention in special cases are:

1. Time and current values on accelerating.
2. Time loss on duty cycle due to varying voltages on different parts of the run. (Due to resistance of track and trolley combined, considered jointly with the compounding effect of motor-generator set.)

The first can be taken into calculation by using the formulas:

$$D = 44TV \qquad (1)$$

$$F = \frac{2{,}000\ (W + L)\ V^2}{29.92D} \qquad (2)$$

Where T = time in minutes required to accelerate the train.
F = force in pounds to be added to running tractive effort to obtain total tractive effort while accelerating.
D = distance in feet required to accelerate train.
V = velocity at running speed in miles per hour.
W and L being the weight of trail load and locomotive respectively in short tons.

In using the foregoing formulas one should carefully consider the details of operation during the acceleration

period. Two motor locomotives are connected through the controller, so that the motors are started in series with all the grid resistance thrown in. As the motors start to pick up speed the controller is advanced, which cuts down the resistance so that a midway point of the controller will cut all the resistance out. The next point throws the motors into parallel with all the resistance in the circuit (one-half on each motor). This resistance is again cut out by advancing through the remaining points of the controller. Thus the motors are started with the full accelerating current, such as may be calculated by using formula (2) in conjunction with the tractive effort part of the characteristic curve. As a rule the accelerating current is limited to the current corresponding to the one hour rating. The voltage throughout the accelerating cycle may be considered as starting at zero and increasing to full load voltage at the end of acceleration.

The second item is taken care of in the "lost time and delays" figure. However, by obtaining a speed curve for the locomotive considered at various voltages, and calculating the line voltages for all critical points on the run, this item can be calculated.

Conclusions

When the size and power requirements have been determined, the choice of the locomotive may be made among several types, any of which being able to deliver the desired service. That choice should be made after carefully considering the ratings and costs of the respective machines. To obtain direct comparison the following items might be tabulated for each locomotive under consideration:

1. Cost of locomotive.
2. Weight of locomotive.
3. Horsepower rating.
4. Horsepower rating as checked by characteristics.
5. Continuous horsepower rating from characteristics.
6. Continuous horsepower rating in per cent of one-hour rating.
7. Continuous horsepower per ton of locomotive.
8. Cost per ton of locomotive.
9. Cost per horsepower of continuous duty.

Items 1, 2, and 3, together with characteristics, are obtained from the manufacturers. Care should be taken in using the cost figure for each machine to make all costs include the same accessory equipment charges. The horsepower rating, as previously explained, is on the one hour basis.

Item 4 is obtained by the formula:

$$\text{One-hour horsepower rating} = \frac{\text{(volts)} \times \text{(amperes at 1-hour rating)} \times \left(\begin{matrix}\text{efficiency without gears at} \\ \text{1-hour rating}\end{matrix}\right)}{746}$$

Using Fig. 1 the 1-hour horsepower rating is:

$$\frac{250 \times 110 \times 0.83}{746} = 30.5 \text{ hp.}$$

Item 5 is similarly found, using the continuous capacity of the motors as shown by the characteristics instead of the one-hour rating. Again using Fig. 1 the continuous horsepower rating is found to be:

$$\frac{250 \times 52 \times 0.87}{746} = 15.3 \text{ hp.}$$

Items 6, 7, 8, and 9 are calculated from the values for the preceding five.

Taking the locomotive containing two motors with characteristics as in Fig. 1, the value of the nine items would be: 1, $5,000 (arbitrarily assumed); 2, 6 tons; 3, 60 hp.; 4, 61 hp.; 5, 30.6 hp.; 6, 50 per cent; 7, 5.1 hp.; 8, $833.33; and 9, $163.41.

The comparison of characteristics for 25 mine locomotives ranging from 4 to 15 tons shows that Item 6, the percentage of one-hour rating obtained by continuous rating, varies from 38 to 69 per cent. Locomotives with the low percentage continuous rating may be satisfactory for gathering work where continuous service is not encountered; however, the high percentages are highly desirable on steady haulage service. Similar comparison of Item 7, continuous horsepower per ton of locomotive, shows a variance from 3.5 to 7.5 hp. per ton. This is also an important figure, to be scrutinized when choosing a locomotive for fairly continuous haulage operation.

Mechanical and electrical features of locomotive construction have not been discussed in this paper, though they might influence the selection of a locomotive to some degree. Magnetic contactor control, dynamic braking, various gear ratios and gear constructions, types of bearings, stabilizers, and springs are all features of locomotive construction that nearly all manufacturers are prepared to discuss with the prospective customer or its representative.

The choice of a mine locomotive usually involves many local conditions the relative importance of which can be understood thoroughly only by the purchaser. He might procure a locomotive that will get the job done, but unless he has considered the various possibilities open to him he is not sure that the choice has been the best possible one.

Factors which usually limit the size of machine that can be purchased are the size of haulageways and gage of track. The latter may not limit the motor capacity if a reachgear type[4] locomotive is used, providing the haulageways can accommodate the larger-dimensioned machine used on this type of construction. The number of shifts per day required to deliver the desired tonnage must be considered against first cost of locomotives of various sizes. If a locomotive having the power desired would be too large for the haulageways or gage, two machines may be purchased to work in tandem. This is common practice. One machine only might give the desired power if equipped with a blower. On the other hand, certain installations when purchased without blowers might be obtained with an eye to the future requirements of the mine. If the tonnage demand increases, the same locomotives can be equipped with blowers to increase their capacity. In so doing, the locomotives might not have sufficient weight to develop the tractive effort which the blowers qualify the motors to develop. In this case the machine may safely be weighted down.

Where large and expensive cars are used the desired tonnage might be obtained more cheaply by running a train of fewer cars than the locomotive is capable of hauling, in order to run at a faster speed, working on the lower values of tractive effort. Speeds as high as 20 miles an hour are being used on underground haulage, but such practice requires perfect roadbeds and very heavy track.

A thorough study of local conditions, together with information on machines available for the job, is necessary to insure the choice of the locomotive best adapted to the service.

[4]This type of locomotive construction makes use of an extra gear between the motor pinion and drive-wheel gear, without any gear reduction. These machines are higher and wider than locomotives with the same size of motors geared directly, but permit the use of larger and better types of motors for operation on narrow-gage track.

Slate Mining in Germany

THE term "slate," as applied to a rock, refers to its textural peculiarity and not, as might be inferred, to a definite mineralogical or even chemical structure. As understood in commerce and industry, slate is a rock having a marked tendency to separate into laminæ that may be utilized as a weatherproof roofing or surfacing material. This definition is, however, sanctioned only by custom, because other rocks which cannot be utilized for these purposes may still be slaty. One of the best examples is that afforded by the Rhenish clay-slate rocks. Although the textural peculiarities of these rocks as a whole justify the use of this term, only in certain localities is slate applicable to commercial purposes mined. In principle, then, the foregoing observations may also be applied to stone-mining operations in slaty rock.

The texture of slate leads one to suppose that the good

Undercutting a wall with a hammer-pick

cleavage properties of the rock in one direction are a function of its slaty character. "Stratification" and "slaty cleavage" are not synonymous terms. Slaty rocks usually occur as the result of a lateral pressure, conceivable as acting somewhat as follows: A fine-grained rock of fairly high but not too high compressive strength when subjected to a unilateral pressure shows that the grains form scales or laminæ at right angles to the direction in which the pressure acts. Because of the high pressure and the initially plastic character of the rock, however, no cohesion exists between the scales. Tests have been performed to explain and demonstrate the phenomenon of exfoliation or "scaling." Wax is of a scaly nature; but under the effect of considerable lateral pressure and counterpressure it is separated into minute layers perpendicular to the direction of shear. Translating this effect into terms of geology, slate may be regarded as being the effect of large shearing stresses—principally tangential—on the oceanic sedimentary deposits that have already been subjected to folding. The force exerting the counter-pressure is supposed to have originated in the older eruptive rocks of solid structure. This will explain (1) the absence of the effect of troughs and saddles in the direction of lamination of slate, and (2) the fact that the laminations mostly run at a steep angle. Further proof of the correctness of this assumption is that the fossils contained in slate are compressed in the direction of thrust and extended in the direction in which the laminæ run. Transverse lamination, frequently referred to in this connection, is often in the direction of the general strike of a range of hills, as, for instance, in the Rhenish *Schiefergebirge,* or Slate Mountains. Other researches attribute the schistose character in definite regions to a contact effect, but these are exceptional.

As the lamination of a rock is regarded as a fairly general property, brief reference may now be made to the factors that govern the technical utilization of slate. The chief requirements in this connection are that the slate be weather-resisting and easy to cleave. If the cleaving properties are a function of the texture, the resistance to weather depends on the mineralogical admixtures. Minerals that are easily soluble and subject to weathering, such as carbonate of lime, pyrite, chalcopyrite, various iron oxides, and alkalies, reduce the technical value of slate because of the ease with which they are attacked by the atmosphere. In addition, slates must be examined for their capacity to absorb water and for their compressive or bending strength and grain formation.

Where possible, slate is mined by opencast methods. In many instances, however, the thickness of the overlying strata makes deeper mining necessary, as it is not economical to remove layers that are too heavy. The method of working depends on various factors such as the dip and thickness of the beds, and the lamination and stratification of the slate, but primarily on the natural cleavage planes, which run approximately at right angles to the laminations.

A pronounced dip, such as usually occurs, generally assists in recovering the slate, because gravity can be used to dislodge the blocks. Type of lamination is no less important. The main criterion of a good roofing slate is that the laminæ be thin. Thick laminæ yield slabs. Whether or not the lamination is more or less pronounced effects the recovery, because this point decides whether shot-firing is necessary or not for dislodging the blocks of slate away from the bed. Special care is required in winning beds of slate that are fissured and interspersed by gangue that cannot be cleaved. The most important factor, however, is the natural cleavage planes in the rock, because these facilitate working.

Roofing slate is usually interspersed with cleavage planes, whereas in slab slate they occur only at intervals or are absent altogether. This is what really gives slab slate its true value. Where the cleavage planes are entirely absent, the slate must be cut artificially to free the blocks at the sides and so release them.

Roofing and slab slate are of two distinct types, so that

Abstracted from *Der Bohrhammer.*

different considerations govern the way in which they are mined or quarried. Roof slate must be easy to transport and to cleave. The maximum size of the blocks to be cut is therefore limited by the available transportation facilities and the cleavage properties, whereas the minimum size is governed by economical considerations. But the slab-slate miner aims to recover the slate as intact blocks and as large as possible; the only limit to size in underground operations is that set by the dimensions of the galleries and shafts through which the slate is transported. For these reasons, blasting is seldom employed in winning slab slate, and then only with black powder. It is frequently employed in winning roofing slate.

Technical methods adopted in mining or quarrying slate must take account of, and be adapted to, the natural conditions of the rock. When samples of slate are obtained for strength tests, the pieces in question must not be dislodged with the hammer, but, if possible, produced by a tool that does not destroy the texture. Heavy impact stresses are deleterious to the slate. The miner allows for this in blasting operations, by using shots that produce a gradually increasing pressure, rather than high-explosive charges.

Not until pneumatic tools were introduced was the slate miner given the right tool for the job; one which, instead of delivering a single blow with great force, delivers a larger number of blows with a smaller but steady force. In this way, deleterious percussive effects on the rock are avoided.

Previously, the miner holed and drilled laboriously with hammer and pick; compressed air now drives the pick into the gray rock. If roofing slate is well interspersed with natural fissures or cleavage planes, holing and cutting may be dispensed with. The hewer applies

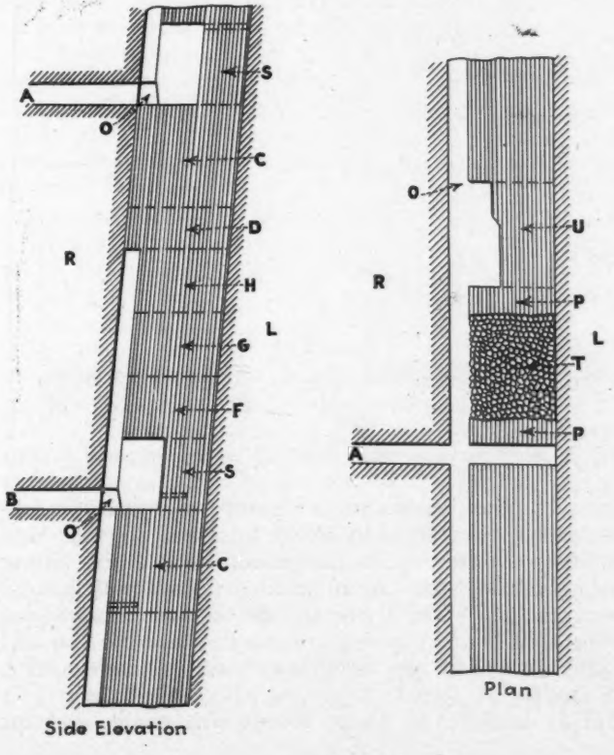
Making side cuts in a wall of slate

the hammer drill in the bank of slate parallel to the level, and blasts the bank clear for the actual operation of recovering the slate. He then continues drilling parallel to the lamination of the slate, finally getting the blocks down with black-powder charges. Working slate in slabs is a more difficult job. As the natural cleavage planes are rarer and often absent altogether, it is generally necessary to hole and cut the slate to get it away. The fundamental method of working underground in cases of pronounced dip is shown in Fig. 1. The several phases of working usually run in this order: (1) working on the level, (2) working in descending steps, and (3) working in ascending steps. After the levels have been worked, sinking is started. The cavity made is then packed with waste, and the overhanging slate is worked by overhand stopes. A roof is left between the several working levels. Several stopes are opened along the strike from the crosscut, the width of the stopes depending on the nature of the roof. Safety pillars are left between the stopes to support the overlying rock. The material in the pillars and the cover-roof is not mined.

In working on the level (Fig. 2), a cut is taken on the level, the slate bank being then loosened by a few pressure blast charges above. If there is no "cleat" in the direction of dip, the sides must first be cut away at right angles to the holing. When working by overhand stopes, cutting is adopted only if there are no natural cleavage planes or "cleats" at the sides (Fig. 3).

If working in descending steps (as shown in Fig. 4) the slate is holed, and, where necessary, cut. When working on the level and in ascending steps, the blocks are brought away by charges of black powder, applied parallel to the level. The application of pressure shots parallel to the laminations of the slate is rarely necessary. When working in descending steps, after holing the slate, to drive in wedges is sufficient, this being assisted, where necessary, by a few black-powder shots.

Fig. 1—Sketch illustrating mining method employed. "A," crosscut of upper working level; "B," crosscut of lower working level; "C," sunk step; "D," cover; "F," first ascending step; "G," second ascending step; "H," third ascending step; "L," floor; "O," the face; "P," safety pillar; "R," roof; "S," level workings; "T," first stope worked out and filled with waste; and "U," second stope



When the slate is worked opencast, the method of working is similar to that adopted when working in descending or ascending steps; that is, the slate is usually worked upward in steps.

Attempts have been made to introduce electrically operated drilling machines for working slate, but the drills stuck in the drill dust. Attempts were then made to generate compressed air simultaneously with the electric drilling in order to blow out the drill dust. This

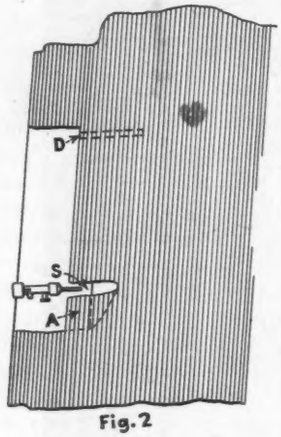


Fig. 2

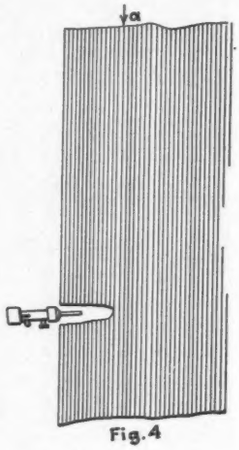


Fig. 4

Fig. 2—Operations on the level. "A," slate being brought away; "D," shot-firing; and "S," holing. Fig. 4—Sinking a step. The portion to be brought away is underholed by hammer picks; and, where cleavage planes are absent, it is cut at the sides at right angles to the holing. The blocks are then cleaved by driving in wedges at "a."

proved extremely complicated, and the output of such a tool was far lower than that of the pneumatic hammer drill.

For drilling holes in a horizontal or slightly inclined direction, the Flottmann Type AZ 11 twin-valve hammer drill, weighing 24¼ lb., in conjunction with spiral drill steels with Z-bits, has proved satisfactory, because its low weight permits handling with ease in every position. For drilling downward holes, a heavy hammer is preferred, owing to its higher efficiency. The additional weight of Type AZ 16, which is slightly more than 10 lb., is no obstacle in this case. The hammer can be supplied with an ordinary or strong blast for blowing out the cuttings.

In mining or quarrying the slate in slabs, holing and cutting are of primary importance. In quarrying operations, strong percussion drills with crown bits are used occasionally, as there is sufficient room to enable this to be done. Conditions are different when working underground, where, owing to restricted space, the weight and inconvenience of the machine are a big drawback, added to which the tall working faces make it difficult to secure the screw columns rigidly. During the operation of the machine they are subject to considerable strain. Under such conditions a handy tool is necessary, one which takes up little room and yet meets requirements in regard to efficiency and reliability. The hammer pick is the tool for such a purpose. Highly percussive hammers are used, fitted with picks having flat bits. As the cutting edges must be at right angles to the hammer handle, the pick shank must be guided in the hammer with an edged guide. Years of experience have indicated that a hexagonal shank-end is best. But it is hexagonal only at the top, the lower portion being cylindrical to insure a good tight fit with the front chamber of the cylinder. Like the hammer drill, the Flottmann hammer pick is also fitted with twin-ball valve control. Various features of design insure a long life with low cost for spares.

A deep cut is made in the following manner: At the height of the breast, a strip of slate about 1½ ft. deep is chiseled out with the hammer pick, as shown in Fig. 2. The portion marked *A* (Fig. 2) is then broken away, and the cut increased to a depth of about 3¼ ft. In the absence of lateral cleavage planes, a cut is made with hammer picks. In special cases, the slate is successfully holed and slotted with the standard hammer drill. Broadly speaking, this consists in making a row of drill-holes exactly parallel to one another and down to the desired depth. To prevent the drills' wandering, what is termed a hole-by-hole drilling apparatus is used for the job. So easily can slab slate be cut away that it is not unusual to get slabs of 110 to 430 sq.ft. in area. As these are too big to be transported through the galleries and shafts, they are split into two or more parts with the hammer pick, waste being reduced to a minimum. Each of the resultant slabs has a smooth and straight edge.

Compressed air is also widely adopted for dressing the slate for the market. The holes in the slabs are often drilled with pneumatic drills. The sand-blasting machine performs valuable service in lettering, and, particularly, in dressing the slate artistically. In modern slate-treating plants, the compressed-air mains are often carried into the forge and machine shop, where they supply the machines for sharpening the rock drills and other tools. Where sufficient compressed air is available, pneumatic rotary piston engines and turbines are used to drive grinding and polishing machines and fans, and this enables the energy in the power house to be utilized to better advantage. Pneumatic tools have come to be widely adopted in slate mining and quarrying during the last few years. A slate pit without a compressed-air plant is rare today, and could certainly not be run profitably.

Of the natural stones, slate is capable of a very wide

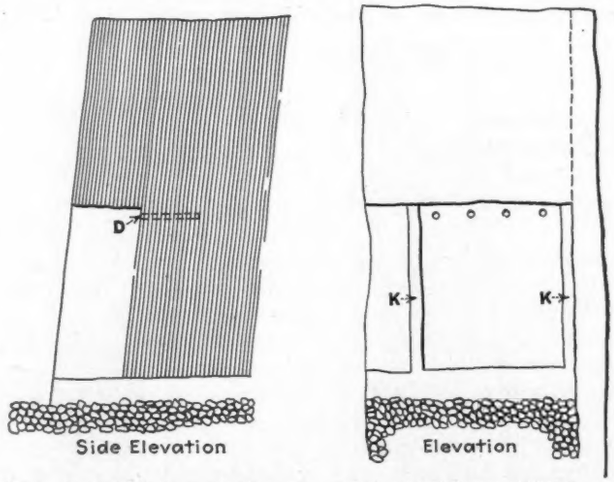


Fig. 3—Working by ascending steps. "D," shot-firing; and "K," cuts

range of uses, thanks to its cleavage characteristics, resistance to weather, and ability to take a polish. As a roofing material it is unequaled, because of lasting properties and the way in which it blends with natural surroundings. The scythe and the slate whetstone are as intimately bound together as the school and the slate and slate pencil, or as lithography and Solnhofen slate. Slab-slate is found in the switchrooms of electricity supply stations, as floors, for paneling walls, and for

billiard tables. Many trades and industries are large users of slate, and artistic effects can be attained with it by simple means.

Owing to the wide range of purposes for which slate can be used, the occurrence of slate or slaty rocks means a great deal, industrially speaking, to various districts in Germany. Slate mining, quarrying, and dressing afford the sole means of livelihood to the populace in regions where there is little nor no other industry. Slate is being mined in the Hunsrueck region (Bundenbach, Kirn); in the Eifel (Kaisersesch, Mayen); on the Moselle (Trarbach, Zell); on the Rhine (Caub); in Westphalia (Nuttlar); in Saxony (Lossnitz), and in many other parts of the country. All these useful deposits are associated with the general strike of the Variscite range of mountains, which folded during the Coal Age and the remains of which form a considerable part of the Central Mountains of the present day (Vosges, Black Forest, Rhenish Schiefergebirge or Slate Mountains, Fichtelgebirge, Thuringian Forest, Harz).

Rare Metals Essential to Industry

IN SPITE of the high cost of the constituent metals, the alloys of the platinum group have considerable use in commercial products. The platinum group comprises platinum, iridium, osmium, palladium, rhodium, and ruthenium, all termed noble metals because of their resistance to corrosion at ordinary temperatures and their resistance to single acids. Chiefly because of this "ultimate corrosion resistance," the platinum metals are employed for such articles as laboratory utensils, surgical instruments, electrical contact points, writing pen points, precision-type resistances, thermocouples, and standard weights. They are also used to electro-plate special decorative hardware, and for this purpose have the advantage of a higher wear resistance than gold and silver.

Although grouped together for convenience because of their similar chemical properties and because of their occurrence together in nature, the metals of the platinum-group and their alloys vary widely in physical properties. Because of their high cost, the designer should seek expert advice in the selection of the right alloy for the particular job in hand. Producers of the alloy metals usually furnish service of this kind. All the metals and alloys of the group are of whitish-gray color. The whiteness, depending somewhat on the physical state of the material and on the smoothness of the surface, is completely lacking in the bluish tinge of nickel or the purple of chromium, and because of this beauty of color the metals are likely to have a widely extended future use for plating. All of the metals of the group have high melting points, ranging from 2,822 deg. F., for palladium, to 4,890 deg. F. for osmium. The hardness varies from the 47 Brinell, for annealed platinum, to 220 Brinell, for annealed ruthenium, or to the even harder metal of the group, osmium.

Platinum is the basic constituent of most of the alloys of the group, the most widely used of which are the platinum-iridium alloys. Russia has been by far the most important producer of the platinum metals, and still is, although large quantities are now obtained from Colombia and South Africa, and as a byproduct of the nickel industry in Canada. Less than seven tons of platinum are produced annually, but the metal is used industrially only in small units, so this quantity covers a wide and important field. Iridium occurs naturally alloyed with osmium. This "osmi-iridium" is used for pen points.

Platinum is extremely ductile and malleable. The metal or any of its alloys is easily worked at bright red heat, and can also be worked cold by rolling, swaging, and drawing. Wire as fine as 0.0005 in. diameter can be bare drawn. By the Wollaston process, wire of 0.00005-in. diameter can be obtained. The metal is also easily spun, so that intricate shapes can be made. Electric or gas welding can be practiced, which makes possible the use of platinum for the points and tips of instruments. Silver and gold solders may also be used on platinum and its alloys.

The pure metal is too soft to use alone for ordinary purposes. As is usual with other metals, the alloys of members of the platinum group are of more commercial importance than the metals themselves. The designer deals chiefly with the platinum-iridium alloy, with perhaps one or more of the other metals as hardeners. The hardness of some of the platinum-iridium alloys is as high as 400 Brinell. Because of this fact, in addition to their resistance to corrosion, they are invaluable in the manufacture of such articles as surgical instruments. Ruthenium and osmium have a still greater hardening effect on platinum than has iridium.

Palladium is the basic constituent of many important alloys, which, owing to their comparatively low price and greater bulk, will probably find ever-increasing uses.

A highly important industrial use of the platinum alloys, outside of the chemical industry, is for electrical contacts and resistances. Platinum is specified for electrical-contact equipment that must not fail in service, such as the ignition systems in airplanes. The metal must withstand severe repeated impact without flattening or crystallizing. A perfect electrical contact must also be assured, even after long operation in moist atmospheres that may contain acids. The metal at the point must have a low vapor pressure, to withstand repeated high temperature arching of the rapid make-and-break. Also, it must not form an oxide on the surface, which would cause high electrical contact resistance.

Platinum and its alloys meet these severe requirements. It has been found that an alloy of 80 per cent platinum and 20 per cent iridium gives the best results. Palladium-silver alloys, particularly the 60-40 mixture, are also used as contacts. These alloys are hard, non-tarnishing, and possess high melting points. Spark plugs with platinum-tipped nickel electrodes have been used where automotive engines are run under severe conditions, particularly high-compression engines, buses, and taxi cabs.

Both solid and composite types of electrical contacts of the noble metals are available. The composite type

Abstract of an article by Frederick E. Carter, of Baker & Company, Inc., in *American Machinist*.

has a solid iridio-platinum disk welded to the face, with a base metal backing to give it sufficient strength. Such contacts are not expensive when the service they render is considered, because the precious metal heads are small, ranging from 0.1 to 0.375 in. diameter and 0.006 to 0.062 in. thickness. Another type of contacts, known as the screw-type, is suitable for heavy-duty service; this type which is of extreme hardness, because of the special composition, may be soldered or welded to the terminal electrodes, but must be ground to size.

Resistances in precision-type electrical instruments are frequently made of platinum alloys, principally because of their non-tarnishability. This is especially true of resistances subjected to highly corrosive atmospheres or high temperatures. Wire and strip of accurate dimensions are generally stocked.

Research is rapidly developing cheaper alloys of the noble metals. Alloys of platinum or palladium with copper, cobalt, or nickel are available. The addition of copper to platinum increases the hardness materially, and the electrical resistance to a remarkable extent. The effect of copper on palladium is less marked, the alloys remaining malleable and ductile and the electrical resistance being only about one-half of that of the corresponding platinum alloys.

Considerable quantities of platinum alloyed with 5 per cent nickel are used as heating filament in radio tubes.

Alloys containing only precious metals do not have as high electrical resistance as the platinum-copper alloys. Only the platinum-iridium alloys have higher resistances than those of platinum-cobalt and platinum-nickel. The platinum-iridium alloys are the most important at present for electrical contacts and resistances. With increasing percentages of iridium in the alloy, both the Brinell hardness and the resistance increase until a maximum is reached, when the content is about 30 per cent. Above 20 per cent, however, the ductility decreases rapidly, so that annealing at a high temperature, usually 1,200 deg. C., is required. At this temperature iridium is somewhat volatile, which prevents the use of the iridium-platinum alloys for thermocouples. The electromotive force does not stay constant.

Osmium has about two and one-half times the hardening effect of iridium on platinum. It also increases the electrical resistance two and one-half times as quickly. It is difficult to work an alloy of more than 10 per cent osmium, because of hardness and lack of ductility.

Alloys of platinum and ruthenium are somewhat similar to platinum-osmium alloys, the ruthenium having about the same hardening effect. The platinum alloys containing osmium and ruthenium lose considerable weight on heating because of the volatilization of the added element.

Palladium does not harden platinum to the same extent as do the other metals of the group. The series is easily workable.

Platinum-rhodium alloys are workable up to 50 per cent of the latter, although only with difficulty in the higher percentages. Rhodium hardens platinum more than does palladium, but less than do the other members of the group. A 10 per cent addition increases the hardness to 165 Brinell, and 50 per cent results in a Brinell of 323. Platinum-rhodium alloys have a lower rate of volatilization than has platinum and do not crystallize readily. These properties led to their use in the manufacture of laboratory utensils and precious-metal thermocouples.

The addition of silver to platinum causes rapid hardening. Alloys with excess silver, such as are used for electrical contacts, are hard but fairly ductile. Even small percentages of platinum seem to reduce the rate of tarnishing of silver.

Metals of the platinum group are also being used for electro-plating. Excellent solutions are on the market for this purpose, which give bright non-tarnishing finishes. They are used for plating fine instruments, automotive fittings, fancy hardware, and novelties, as well as jewelry, wherever non-tarnishing properties are required.

Of all the platinum-group metals, palladium is the one most used for plated articles. It has practically 100 per cent "throwing power," making it suitable for plating difficult shapes having re-entrant angles. It also will plate evenly, regardless of the contours of the work. Articles such as cigarette cases, interior hardware for automobiles, spectacle frames, and many others are now plated with palladium. Rhodium plating baths are also in use, giving a particularly brilliant finish because of the high reflecting power of rhodium. The cost of plating with palladium is only slightly higher than with gold, because the volumes obtained per unit cost are almost equal. Gold is nearly twice as heavy as palladium and costs about half as much. The material cost being about the same, palladium can be used where its fine frosty white color appeals to the purchaser.

Lead Slags Investigated at the Furnace Tuyères

THE fifth of a series of publications recently issued by the U. S. Bureau of Mines on the general subject of smelting in the lead blast furnace is a discussion of the effect of conditions at various tuyères on the form in which lead is present at that point in the furnace and on the composition of the slag. Samples were taken at the Tooele, Utah, plant of International Smelting, and were obtained by inserting a ½-in. steel rod in the various tuyères, and collecting the adherent material after removal.

Conclusions given by Messrs. G. L. Oldright and Virgil Miller in their latest report follow:

1. The amount of lead silicate increases sharply at first in going from the slag tap to the back of the furnace, because of the drop in the concentration of carbon monoxide and in the temperature. This increase in the amount of lead silicate continues to a point about the middle one of the tuyères as the temperature and carbon monoxide concentrations continue to lessen, and as up to this point the downward movement of the charge is still rapid. Then, as the charge moves with decreasing speed as the back of the furnace is approached, the factors influencing reduction have longer time to act, so that in this part of the tuyère zone the amount of lead silicate drops steadily.

2. The experimental fact that lead silicate is present in the slag to a considerable extent shows that the easily reducible compound has been present in such a physical form that carbon monoxide could not attack it. After fusion, lead silicate, which is then very liquid, moves so rapidly past the tuyère zone that the assistance of the replacing power of calcium oxide or metallic iron is needed to assist the carbon monoxide.

3. Temperatures obtaining at the various tuyères also determine the slag-forming constituents of the slags

made at each tuyère. Thus with the higher temperatures the slags contain more lime in proportion to silica *and less lead.*

The iron in the slag increases when the temperature drops, notwithstanding the fact that the carbon monoxide concentration drops with temperature and the iron compounds would be less strongly reduced. The lime that is present replaces the iron and the lead.

Financial Loss Represented by Mine Accidents

MINE accidents in the United States, in addition to causing deplorable loss of life, are extremely expensive to mining companies and to miners, says the U. S. Bureau of Mines. In the metal-mining industry, in a recent typical year, 430 men were killed and 30,350 men received lost-time but non-fatal injuries as a result of accidents. An average of 114 days was lost for each of these fatal and non-fatal injuries, again computing a fatality as 6,000 days' lost time. This is equivalent to 3,523,944 days' time lost due to accident; or, at $5 per day per man, to a wage loss of $17,619,720. Again, deducting one-ninth of this figure for compensation paid, the metal miner loses in wages annually about $15,700,000, or about $122 per individual. This average loss per individual includes the cost of fatal accidents reckoned at 6,000 days, or $30,000, but even if the loss in time due to fatal accidents be deducted, the average cost of each individual metal miner each year for non-fatal accidents is about $32.

Estimating the loss to the metal-mine employer as about the same as that to the employee, the annual cost of metal-mine accidents to the employer is about $15,700,000; to employer and miner the total reaches $31,400,000.

The Bureau of Mines has concluded from its work with mine operators, state mine-inspection departments, and miners' organizations that the following factors are among those vital to the lessening of accidents in the mining industry:

Mine management from the top down, and including all subordinate officials, must be thoroughly converted to the idea and practice of safety.

The mining company should have a safety organization of officials and miners. This organization should work continually toward the study and betterment of safety conditions in the mine, the investigation and fixing of responsibility for all accidents—including non-injury accidents—and the education of officials and miners in proper safety practices.

Safety requirements in the state law should be obeyed, and such additional safety rules as are needed to cover local conditions and practices not possible or perhaps desirable to control by general legislation should be made. Measures should be taken to insure that officials know these laws and rules and that miners know at least such portions of them as directly concern their safety and that of others.

The mining system and the number of officials should be such that rigid discipline in regard to safety should be possible and practiced at all times. Properly to discipline a careless or wilfully unsafe man, whether official or miner, should be possible. Such men, if not amenable to discipline, belong outside the mine.

Mine officials and miners should be educated in safety and accident prevention. This education is more or less a continuous process.

Demands for mine production must not be allowed to outweigh or precede safety considerations.

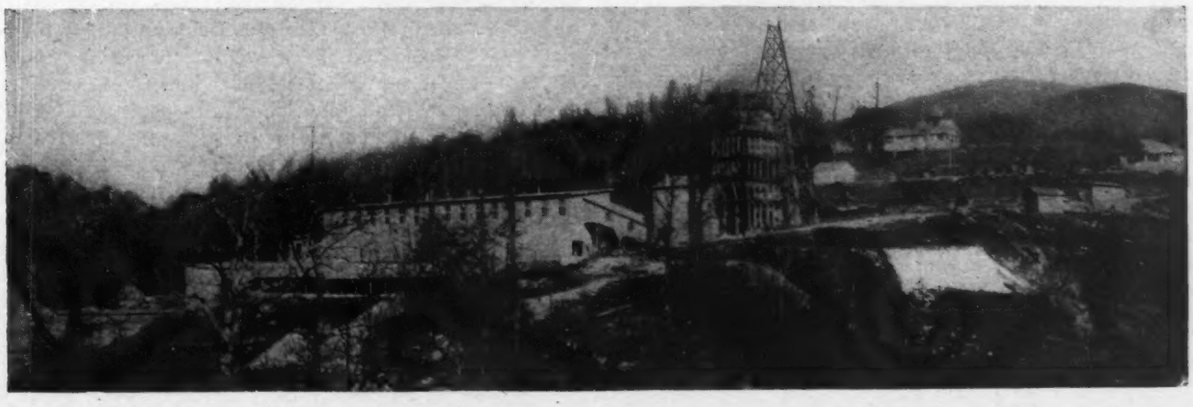
Adequate mechanical safeguards should be provided for all mechanical and electrical equipment, in order to minimize the man-contact hazard with moving machinery or with electricity.

Each state should have a code of laws adequate to cover the requirements of mine safety; it should have an inspection department adequately manned and financed, with a personnel trained, alert, and with the power properly to preserve the safety of miner and mine official. Authority should be invested in a committee or commission to change or to promulgate new rules and regulations as the changing conditions of mining require.

Mine accidents represent a definite and important part in production costs and a large financial loss to operator, miner, and the general public. The mine-accident rate in the United States is high. It has not diminished as it can and should diminish, although some mining companies have obtained a definite accident lessening. Through the successful experience of these companies, other companies can achieve similar results if the will to do so is there and is properly supported.

Additional details regarding Mr. Denny's study are given in Information Circular 6166, "Accident Cost and Mine Safety," copies of which may be obtained from the Bureau of Mines, Washington, D. C.

Plant of Tennessee Mineral Products at Spruce Pine, N. C.



Operating a Gold Property in the PHILIPPINE ISLANDS

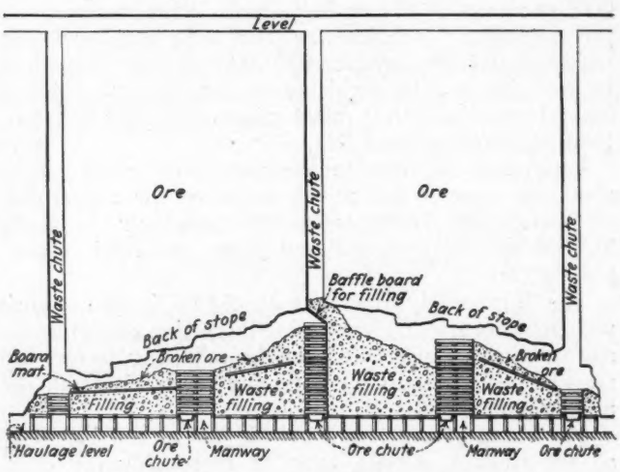
F. M. KURIE
General Manager, Syndicate Mining Company, Rio Guinobatan, Masbate, P. I.

THE ARRORY MINING DISTRICT, in the Philippine Islands, was known to the natives and to Spaniards long before 1898, when the islands became American territory. Moreover, some placer ground and outcrops of rich veins had been worked by Chinese for centuries. No attempt at systematic prospecting, however, was made until 1901, when several experienced American prospectors entered the district and located nearly all the claims since proved to be of value. Most of the claims of the Syndicate Mining Company were located at this time.

The cyanide mill of the company was designed and built by H. C. Wilmot and placed in operation early in 1914. Power-plant equipment includes one small Bentz engine, two Mirrless engines, and one Busch Sulzer Diesel engine. Electric generators are directly connected to the engines. The four engines together provide 550 hp. Crude oil from the Borneo fields is used for fuel, making the cost per horsepower-hour about one cent. Each unit of the mill is operated by a separate motor. The country surrounding the Barrio of Rio Guinobatan, where the mine is situated, is andesite and basalt; no other formation is exposed in the mine workings or in any of the outcrops to be seen near the property. The basalt, which is the result of segregations of augite, does not intrude into the andesite, but the two formations merge into each other. The mine is in a long ridge which rises to a height of 500 ft. above the level of the mill. Along the crest of this ridge is a shear zone 500 ft. wide in which the veins occur. The rock of this zone is crushed and altered until it is but little harder than dry clay in most places, and it is not nearly so hard as the unaltered andesite anywhere in the shear zone. The shear zone carries from $2 to $4 per ton across its entire width, and is reddish brown in color. In width the veins vary from 4 to 50 ft., and the gold they carry per ton ranges from $6 up to high value. Gangue minerals of the veins are quartz and calcite. Frequently the crushed andesite is of sufficiently high grade to be ore. The veins are heavily stained with pyrolusite and the vugs are often coated with psilomelane. Pyrite in small crystals is scattered through the veins. Copper occurs at times, but not in sufficient quantity to affect milling operations. Faults are frequently encountered, but most of them are parallel to the veins, so that the latter are not often troublesomely displaced. These faults are usually older than the veins.

The mine is worked through two crosscut tunnels. The upper or No. 3 tunnel is about 250 ft. above the level of the mill. All ore mined above it is passed down to it through raises and trammed to a bin at the head of a gravity tramway by which it is taken down to the mill. No. 6 tunnel is on an level with the mill. All ore mined between it and the No. 3 tunnel is passed down to it through raises and is trammed to the mill. All tramming is done by hand.

In the shear zone, the ground is so soft that all drifts, crosscuts, and raises must be securely timbered to prevent caving. Caves do occur at times in spite of the timbering. All stopes are worked by the same method. When a stope is to be started raises are first driven to the level above for waste chutes. As the stope is worked upward, waste is brought down and the stope is kept filled, leaving head room only under the back.



Sketch showing stoping method employed

Ore chutes and manways are cribbed up through the filling. Where the rock is hard, water Leyner drills and Denver Rock Drill jackhammers are used, but where the rock is soft, hand augers are used for boring. The accompanying sketch shows the stoping method.

Mine and mill superintendents, most of the shift bosses, and the chief of the office force are Americans. The remainder of the company's 700 employees are Filipinos. The efficiency of the Filipino miner is about one-sixth that of the average miner in the Western states. Their average wage is 1.25 pesos, or 62½c. gold, per nine-hour day. When the losses caused by their neglect of duty and thefts, together with their low efficiency, are considered, it is clear that they do not comprise on economical source of labor. The most satisfactory way to handle Philippine labor is to contract everything that can be contracted. Mine drifts, crosscuts, and raises are all driven by contract, the price paid depending on the hardness of the rock and the distance the muck is trammed. The ore is also trammed by contract, the price per 1,000-lb. car depending on the distance trammed. Timber is cut on the company's timber concessions at so much per stick delivered at tidewater; the price paid depends on the size of the stick.

In addition to its mining and milling operations, the company owns a general store and a motion-picture

theater for the benefit of its employees. It also owns 100 nipa houses in the Barrio of Rio Guinobatan, which are let to its employees at a low rental.

Ships can come only within half a mile of the shore, and the company does lightering for the other mines operating in this district and for the merchants in the surrounding country. Two motor boats and several scows are used for this purpose. A small motor ship owned by the company is used for bringing mine timber from distant points. Trucks are used for hauling supplies from the landing to the mine, which is 5 miles inland from the waterfront.

One of Chile Copper's Huge Blasts

AN UNUSUALLY large blast made some years ago at the open-pit copper mine of the Chile Copper Company, at Chuquicamata, is shown in the accompanying striking picture, the photograph being taken by P. O. Weston. The actual ground being broken is the rounded island-like mass 200 meters wide just below the smoke. At the moment the exposure was made the ground had already swollen considerably owing to the force of the explosion. When the smoke finally cleared away, the mass was greatly flattened, the broken rock having spread out in all directions, leaving no trace of the original steep bank. The cauliflower effect given by the smoke is caused by the explosion's breaking up through some of the churn-drill holes. No signs are here visible of flying fragments of rock; black powder blasts often do not throw the material far; whereas with dynamite or liquid oxygen the throw of boulders aids in their fragmentation. However, on the right center, high in the air, will be noticed a black object which is a 6-in. steel pipe casing, probably 15 ft. long, the jet of smoke issuing from which was evidently caused by an accumulation of pressure therein at the moment of explosion.

The block of ground broken was largely waste material left in place while ore was being extracted from the more exposed sections toward the center of the mine. Development for blasting consisted of tunnels, and sprung churn-drill holes drilled above the tunnels.

The following details, supplied by Alan M. Rodgers, who also sent the photograph, may be of interest:

Height of face, 36 to 49 ft.

Number of churn drill holes blasted, 221.

Spacing of holes, 26 to 33 ft.

Total length of tunnels blasted, 2,549 ft.

Total tons broken, 677,500. Tons broken per pound of explosive: black powder, 0.76; dynamite, 1.94.

Total pounds dynamite used in springing, 65,725.

Total pounds dynamite used in blasting, 233,275.

Total pounds black powder used, 514,100.

Grand total of explosives used to break the ground, including springing, 813,100 lb., or 406.5 tons.

Total pounds explosive used at time shot was fired, 747,375, or 373.7 tons.

Digest of Current Literature

Italian Bauxite. G. Crema. *Giornale di chimica industriale.* October, 1929. In a report to the eighteenth meeting of the Societa Italiana per il Progresso delle Scienze (Florence, September, 1929), it is stated that the Italian government's survey in the Province of Otranto has revealed bauxite deposits of considerable importance. They compare favorably in extent, richness, and favorable position with the previously known deposits in the Province of Istria. It is also noted that the calcareous bauxites in the Province of Foggia are more extensive than the first survey had indicated. Results of these surveys are considered to be important to the Italian aluminum industry.

Copper Sulphide. Kurt Fishbeck and Oskar Dorner. *Zeitschrift für anorganische Chemie.* Nov. 7, 1929. The conditions of formation and decomposition of cuprous and cupric sulphide have been investigated. In the action of sulphur on metallic copper the first stage, formation of cuprous sulphide, proceeds very rapidly, but the formation of cupric sulphide is quite slow at ordinary temperatures. For an increase of 10 deg. C., starting from room temperature, the reaction rate increases about 3.5 times, so that at high temperatures this reaction also becomes very rapid. It is necessary for the sulphur to diffuse through the surface film of cupric sulphide before it can react with the cuprous sulphide. A temperature rise increases both the concentration gradient and the rate of diffusion, which accounts for the rapid increase in reaction rate with rising temperature. The thermal nature of copper sulphide treatments and reactions is discussed on this basis, as related to the thermal properties of copper, its two sulphides and free sulphur. Mathematical equations are developed for the conditions governing the reaction rates, with respect to formation and decomposition of the copper sulphides. Experimental data of the investigation are presented in tables and curves—for example, for absorption of sulphur by cuprous sulphide as a function of time.

Assay Copper. *Metall und Erz.* November, first number, 1929. The Assay Chemists' Committee of the Gesellschaft Deutscher Metallhütten-und Bergleute was requested to clear up certain discrepancies and misunderstandings in official assays of crude copper, and to recommend procedures for sampling and assay of such copper. Differences as large as 0.51 per cent were found in the copper content of one lot sold by a smelter to a refiner. The higher figure was the average for borings from 20 per cent of the sheets in the consignment; the lower figure included borings from 40 per cent of the sheets. The committee, on the basis of its findings, makes the following recommendation to smelters for assaying their output:

(1) Sample at least 20 per cent of the sheets or bars of a lot; more if any unusual lack of uniformity is suspected. (2) Mark sheets or bars from each furnace charge so the sampler can make sure each charge is represented. (3) Bore clear through each piece, from both sides toward the center if necessary. (4) Stamp the borings and classify in three parts, using a 36- and a 400-mesh (per square centimeter) sieve. Remove iron particles with a magnet.

For the analysis, the committee recommends an electrolytic procedure which is slightly modified from its standard method of 1924. Attention is called to the influence of tellurium, selenium, antimony, lead, molybdenum, bismuth, arsenic, and silver on the analysis.

Low Grade Matte. H. R. Potts. *Metal Industry,* (London). Nov. 1, 1929. Ordinary mattes may contain, in addition to the cuprous and ferrous sulphides, sulphides of zinc, lead, bismuth, nickel, arsenic, and antimony. The low-grade matte produced by the pyrite smelting furnaces at Rio Tinto, however, presents the possibility of contamination with magnetic oxide of iron. Rio Tinto mattes are, however, quite constant in sulphur content, showing little variation from 25 per cent. This is short by about 8 per cent of the amount of sulphur required to combine with the iron, copper, zinc, and lead present in the matte; free iron and its magnetic oxide probably account for most of the deficit. Bessemerizing of matte involves two main reactions of oxygen, one with the iron sulphide and one with the cuprous sulphide. The latter is the critical stage in the conversion; the cuprous sulphide must store enough heat from the first stage to carry the reaction to successful completion. The Rio Tinto converter plant uses five standard Great Falls 12-ft. converters having 22 tuyères, 1¼ in. in diameter, made of solid-drawn steel tubing. These converters have magnesite lining, 19 in. thick on the tuyère side, 15 in. thick on the opposite half, with bottoms 13½ to 15 in. thick. Bricks are set with a magnesite-water cement. Generally the tuyère belt requires repairing after about three months of operation (after about 1,200 tons of copper output). Eight to ten days' time is required to cool a converter, repair the tuyère belt, and dry a new lining. A converter at full capacity takes about 7,000 cu.ft. of air per minute. Several operating difficulties not yet solved are stated and discussed.

Electrolytic Zinc. Georg Eger. *Chemiker-Zeitung.* Nov. 6 and 13, 1929. The soluble anode method of electrolytic zinc refining, though attractive enough to have been the object of a large amount of experimental research (especially during the war), has not achieved any commercial success. This will remain true as long as there exists (as now and in the past) only a narrow price differential between refined zinc and the low-grade or scrap metal. Hence the type of process using insoluble anodes occupies the field alone. In present practice, the zinc solution needed for the electrolyte is obtained by leaching zinckferous ores or metallurgical materials. When the electrolyte is zinc sulphate, sulphuric acid accumulates at the anode; with zinc chloride, chlorine gas is obtained in marketable form. Experience of the early development years showed that this process, more than any other metal refining method, required thorough preliminary purification of the electrolyte solution to make it yield a good non-porous deposit. The maximum permissible amounts of impurities vary somewhat with conditions, but are in general about 10 mg. of copper, 1 mg. of arsenic, 30 mg. of iron, 12 mg. of cadmium, and 1 mg. of cobalt per liter of solution. Modern development of the process had to wait until this was recognized; and on this foundation use of chloride electrolyte has given way to sulphate, using lead anodes in a bath without diaphragms. Oxide ore (roasted if necessary) is required for leaching with sulphuric acid to make the electrolyte. Current practice of this method, as followed in several European works, is described; and reference is also made to the Anaconda, Consolidated Mining & Smelting, and Electrolytic Zinc Company, of Australasia, enterprises.

Conveyor Costs. G. Hollweg. *Braunkohle.* Nov. 2 and 9, 1929. A detailed cost comparison is made of the belt, link, and bucket types of conveyors, to ascertain the conditions of materials handling in which one type is preferable to the others. Installation, operating, maintenance, and depreciation costs are considered. For belt conveyors, rubber belts are used for comparison because of their longer life as compared with textile belts. Balata belts are considered equivalent to rubber. The mathematical basis of the cost comparison is developed, with equations for calculating actual cost per unit of material handled over a given distance in a given time. For horizontal conveying, the belt conveyor is found to be generally preferable; the bucket type is out of the question, and the link conveyor becomes equal in economy to the belt conveyor from about 200 tons per hour up, when the number of operating hours is as low as 1,000. For 3,000 or more operating hours, the belt conveyor retains its superiority at all hourly loads. For conveying on an inclined plane, up to 20 deg. inclination, the belt conveyor is still the most economical for loads up to 100 tons per hour. For larger loads the link conveyor is more economical, for lengths up to about 60 ft., with loads which depend on the angle (over 175 tons per hour at 10 deg.; over 125 tons per hour at 20 deg.). In the inclination range from 20 to 50 deg. the link conveyor is most economical. Even for lifting, the belt conveyor is still the most economical for small loads and a small rise (less than 100 tons per hour, and less than 60 ft. rise). Bucket conveyors find their field of use mainly in lifting loads for which the belt conveyor is not suitable in many of these applications close calculation is still needed as between the link and bucket types of conveyor.

Flotation of Lead Sulphate: *Chemical Engineering and Mining Review,* May 10, 1929. Mr. E. T. Henderson, chief metallurgist for the Broken Hill Proprietary Company, at Broken Hill, N.S.W., has evolved a process which is the first successful application of the principle of flotation to lead sulphate. The Proprietary mine has on the surface some 500,000 tons of residues containing 8.7 per cent lead, of which 7.7 per cent exists as sulphate, and 1 per cent as sulphide, together with 4 oz. of silver and 2 per cent zinc. A brief account of the plant and the sequence of op-

eration is contained in the recent report of the New South Wales Department of Mines and is as follows:

Two Barber-Green mechanical loading machines obtain the material from the dump and deliver it either direct to a Vortex mixer or to a belt conveyor leading thereto. These machines are mobile and self-contained, inasmuch as they may be moved on caterpillar tractors, under their own power, a petrol internal combustion engine. They can each, under the best conditions, move upward of 70 tons per hour at low cost.

The residues are pulped in a Vortex mixer, and pumped by means of a three-throw pump to a mixer at the plant. The pulp is then elevated to a cone classifier which removes the sand. Then the pulp is broken down with clear water to approximately 30 per cent solids. A little sulphuric acid is added to the boot of the elevator to acidify the solution temporarily. Acidification is, however, cut out when the pulp overflows at the classifier by the presence of carbonates in the ore. The flotation is made in a circuit which is neutral to methyl orange.

Next, the pulp passes to mixers where a little Aërofloat is added; additional quantities of this frothing agent are also added subsequent to the agitators. Then the pulp goes to the flotation boxes, which are of usual design; while undergoing agitation in these, in addition to the Aërofloat, a little hydrogen sulphide is drawn in with the air. This gas acts more as an activating agent than for the purpose of resulphiding the sulphate particles.

The first flotation concentrate from the boxes contains 35 per cent lead, of which 30 per cent is sulphate and 5 per cent sulphide. These concentrates are re-treated by being mixed with clear water, slightly acidified, and refloated with a little Aërofloat, but no sulphuretted hydrogen, giving a final product of 45 per cent lead, 20 oz. silver, and 5 per cent zinc. The tailing contains from 1.8 to 2.0 per cent lead.

The tailing discharge and any clear water returned from re-treatment is lime treated before passing to Dorr thickeners. This throws out all base-metal salts and assists in settling the slime in the Dorr thickener. The clear water overflow from the Dorr thickener is used for breaking down the pulp at the head of the system. The plant, which is re-treating the slime dump, has been in operation since January, 1929. At present it is treating about 4,000 tons of residues per week. A recent report states that although a certain amount of success has been achieved, results so far have not been up to expectations.

Ford Scrap Useful

COLD CHISELS, driftpins, and similar tools can be made from old Ford rear axle shafts and crowbars and buggy bars from the drive shafts. This steel can be purchased at a much lower figure than steel ordinarily used for the purpose, and it gives as good if not better results. It is always best to buy such steel when the opportunity presents itself, as it can be used for so many different purposes around the shop or plant. It can be machined in the lathe and worked in the forge. The blacksmith can make it as hard as he desires and draw the temper to any desired color. It will stand abuse and outlast most of the steels on the market.

Useful Operating Ideas

Poster issued by the Prevention of Accidents Committee, Johannesburg, Transvaal

Old Balata Belting Makes Efficient Hand Guard

THROUGH the courtesy of Edmund Steinberg, secretary to the Prevention of Accidents Committee of the Rand Mutual Insurance Company, we are able to reproduce herewith one of the committee's posters, illustrating the use of a novel and efficient hand guard, to prevent injury to miners when barring down rock. It is made of old balata belting, and is about 7 in. long from the small aperture at the apex to the base of the cone, which is 8 in. diameter. A grip strap is provided inside the cone.

Reports from the mines indicate the value of the idea. The guard has prevented many accidents, thereby reducing delays and the expense of injuries.

To Remove Chips From Pulp

An interesting piece of machinery at the Old Dominion mill, Globe, Ariz., is the shovel wheel, used for removing wood chips from the ore before it goes to the fine-grinding units. It is about 3 ft. in diameter and looks like a ferry-boat paddle wheel. The blades are about 6 in. square. The wheel is set up with the axle so pitched at a steep angle that the blades scrape the ore up an incline out of a box leaving the chips behind in the water.

When the Sparks Fly

Use of a damp cloth around the drill when drilling holes in concrete floors or walls will keep sparks from falling in combustible material and in places where a fire might start.

Feeding Flotation Reagents at Old Dominion

A NOVEL MACHINE at the Old Dominion mill, Globe, Ariz., is a reagent feeder, which consists of vertical revolving disks along the perimeters of which are pins or lugs set at regular intervals. On the lugs are hung small buckets of a few cubic centimeters' capacity each. These pick up the reagent solution from a reservoir located at the bottom point of the disk revolution and are tripped to discharge their loads at the top of the revolution. The amount of reagent delivered per hour can be varied by changing the number of buckets on the disk.

Flotation reagents used at present consist of potassium ethyl xanthate, pine oil, reconstructed oil, and lime. The lime is fed dry to the ore stream on the conveyor belt as it leaves the crushing plant.

Sampling a Furnace Bottom

Sometimes it may be necessary to take samples from the bottom of a furnace or a settler while in operation, in order to determine if segregation is taking place. The following simple procedure is employed at one plant to take samples from the bottom of reverberatories.

A pipe of two or three inches' diameter is closed at one end with a tapered wooden plug. The plugged end is forced down to the bottom of the furnace, where the hot metal chars the plug in a few moments, causing it to release and float to the top of the bath. The metal from the bottom is immediately forced up into the pipe to the level of the outside bath, and a sample may then easily be dipped out.

COMMENT AND CRITICISM

Soviet Russia and the Engineer

To the Editor of "E.&M.J.":

In the leading article of your issue of Nov. 16 last, under title "American Engineers in Russia, and the Claims of Russo-Asiatic Against the Soviet Government," you refer to a letter from myself appearing in the same issue under the heading "In the Interest of Common Morality," and in which I expressed the opinion that American engineers when fully seized of the facts would refuse to be employed by the Soviet government in the rehabilitation of non-ferrous metal properties which were expropriated from the previous British and other owners without compensation. In other words, that American engineers would not lend themselves to be employed by a self-confessed thief, namely the Soviet government, in the beneficiation of stolen property.

In your leading article on this subject you express yourself so clearly as to the effect of such work by American engineers that I beg you to permit me to emphasize the dangerous possibilities by quoting your remarks with which I entirely agree:

"In furthering the rehabilitation of Russian industry, American engineers may well be accused of a short-sightedness and lack of patriotism that eventually will enrich Russia and may deprive the United States of a valuable export market. Every major industry in Russia is being remodeled. The United States, through its technicians, is providing the Soviet authorities with methods and machines that will be adopted and copied in the work of revolutionizing production and trade in that country, insuring not only an independence from foreign sources of supply but hastening the day when Russia, by reason of vast national resources and abundant labor, will be able to compete successfully in the markets of the world."

In your ultimate paragraph, however, you summarize the position as follows:

"The return of the properties belonging to the Russo-Asiatic Company appears to be out of the question. As the only alternative, one can well hope that the utilization of expert American experience and knowledge in the rehabilitation of the non-ferrous industries of the U.S.S.R. will hasten the day when the claims of Russo-Asiatic will be paid in full. The influence of public opinion and official action in the United States should be exerted to that end."

With this finding I entirely disagree. If, as a result of the rehabilitation of the non-ferrous metal industries of the U.S.S.R., the Soviet government obtains command of further financial resources, the history of the activities of the Soviet government for the past twelve years would go to refute without any question the hope which you express that the claims of the Russo-Asiatic or of any other claimant will be paid in full.

The Soviet government has always refused to recognize any of the liabilities of the past government and in all my negotiations with them during the past twelve years I have always been officially informed that the past was a cataclysm of nature and that all creditors were advised to forget that they ever had anything to receive from the Soviet government. They repudiate *in toto* all the claims and liabilities against the late Imperial Government and their own so far as property expropriated from previous owners is concerned. The Soviet official attitude confirms this statement absolutely.

The one aim and object of the Soviet government has been to undermine the present basis of civilization with a view to proselytizing the whole world to the Communist creed. The Russian Communist party who appoint the members of the Soviet government and who are responsible for the Third Internationale, which is their tool, look on their foreign trade as the economic weapon in their hands to bring about world revolution, and we have the fullest proof today that in exporting Russian products abroad they do so at prices far below those which they can obtain in their own country. While Russia itself is hungering for light and oil, kerosene and other oil products are exported for their financial requirements and foreign propaganda. In distributing their oil in England, India, and other countries, they do so at a loss, but are satisfied so long as they can undermine the prosperity of competing industries.

That Russia and the Russian people are simply being used as a stepping stone to world revolution is shown by the cynical statement made by Lenin that "it did not matter if a few millions of Russians died of starvation so long as the glorious principles of Communism were upheld."

Stalin and the Political Bureau of the Communist Party who keep themselves in power by the most terrible weapon that has ever been forged to terrorize the human race, the Cheka or Ogpu, are ruthlessly enforcing the principles that Lenin laid down.

May I submit that the hopeful summary in your leading article as to the results of the efforts of American engineers in rehabilitating Russian industry are shared by no one who has had personal knowledge and experience of Russia and the Soviet government. On the contrary, we are all firmly imbued with the opinion that if the Soviet government succeeds with its five-year program of rehabilitation of Russian industry, this will put into their hands financial resources which will destroy or at least do the greatest possible harm to our civilization.

LESLIE URQUHART.

London, England.

[Opportunity to present Mr. Urquhart's comment is appreciated. It constitutes an appropriate conclusion to the discussion of the subject.—EDITOR.]

Comment From Canada

To the Editor of "E.&M.J.":

In respect to the employment of American engineers by the Soviet government, I have been considerably surprised by the attitude of *Engineering and Mining Journal* on this matter, and I think that Mr. Garrison in the issue of Nov. 30 has expressed not only his own opinions but likewise those of all reputable engineers on the question. The crimes of the Union of Soviet Socialist Republics (to give it its somewhat grandiloquent title) are too well known to need recapitulation. In plain English, it is the blackguard among governments; nor has it ever shown at any time evidence of a change of heart.

The government of the United States of America, greatly to its credit, has consistently refused to treat with the Soviet, and I think citizens of the United States would be well advised to pattern their own conduct on that of their government.

You state editorially that "no engineer should be held responsible for the past misdeeds of an employer." The answer to that is that the misdeeds of the Soviet government are not merely things of the past, but continue into the present, and to my way of thinking no man of honor can allow himself to be used by such a coterie of scoundrels.

In respect to the rehabilitation of Russia, of which you speak, its success under the Soviet means the triumph of rascality and dishonor, with the addition that a cruel yoke of bondage will be more firmly riveted on the neck of an unfortunate people; nor is that all, for the unprincipled oligarchy at Moscow will undoubtedly use their enhanced revenues and resources to the detriment of all other governments, including also that of the United States.

J. A. REID.

Toronto, Ont.

[The friendliness that prompted these animadversions from Canada will not be questioned, but United States citizens who sell goods or professional services to the Soviet will recall that, as recently as the middle of last month, the United States government sold to a Mr. Johann

G. Ohsol, an American citizen of New York, twenty-five cargo vessels, to be transferred by him to the U.S.S.R. The contract specified that these vessels, for a period of at least five years, shall be operated between Vladivostok, Siberia, and Petropavlovsk Kamchatka, Siberia; and between Black Sea ports and Leningrad. In other words, they may not return to the United States within that time.—Editor.]

Contamination of Cyanide Solutions With Iron

To the Editor of "E.&M.J.":

Replying to the letter of Mr. H. S. Wildman in your issue of Nov. 23, I have made some tests along the lines he indicates, and find that his main contention is correct and that most, if not all, of the difference shown in my tests between the iron- and rubber-lined mills was almost certainly due to an oxidation of the fine metallic iron to the ferrous state before the addition of lime and cyanide.

His paragraph on the action of tap water on pyrites is really foreign to the subject to my original letter, which was concerned solely with the effect of metallic iron. but I might say, in passing, that his suggestion as to the instant formation of CaS by the H_2S he supposes to be evolved seems to me doubtful, since I have the impression that CaS is rarely and difficultly formed in wet reactions.

Mr. Wildman's comments on his experiment with the two iron balls does not seem to afford any explanation as to why the presence of lime should react to prevent the oxidation of the iron. If, however, we assume the generally accepted theory that the presence of CO_2 is a necessary concomitant in the rusting of iron, it becomes at once easy to see the reason for the inhibiting effect of the lime, which of course would neutralize the CO_2 with formation of $CaCO_3$. Thus, instead of the ferrous hydroxide that Mr. Wildman suggests, we should have ferrous carbonate as the primary stage in the oxidation of the metallic iron. It would seem probable that ferrous carbonate would react with cyanide in a manner similar to that of ferrous hydroxide.

I append the results of my latest tests bearing on this subject. They were made on different shipments from the same mine and are therefore similar in character.

The following points may be noted:

1. In both tests the rubber-lined mill, whether lime were used in grinding or not, shows a small advantage in cyanide consumption over the iron-lined mill grinding with lime, the difference being 0.3 lb. per ton in test No. 1 and from 0.7 to 0.5 lb. in test No. 2.

2. In test No. 1 the rubber-lined mill shows a small gain in extraction over the iron-lined mill, even when lime was used in grinding, but in test No. 2 there is no difference. The probability is, therefore, that differences in extraction shown in my original tests were due to the presence of ferrous iron and not to the presence of iron *per se*.

3. In both tests the rubber-lined mill gave better extractions when lime was not used in grinding. It would not be safe to press this indication too far without further confirmatory tests, but if it be true it is very interesting academically, though it may not have much practical importance, since in almost all commercial plants grinding would ordinarily be done in cyanide solution with the usual protective alkali.

4. Both tests seem to bear out the thesis in Mr. Wildman's letter, and my thanks are due to him for calling my attention to a point I had overlooked, and to *E.&M.J.*. for affording this discussion the hospitality of its columns.

E. M. HAMILTON.

San Francisco, Calif.

To the Editor of "E.&M.J.":

I have followed with interest the discussions regarding cyanide consumption from metallic iron derived from the grinding media used in milling. I have never done any research work in this connection, but I doubt the influence of metallic iron on the weak cyanide solutions used for simple gold ores. In changing from a flint-pebble charge in our tube mill to cast-iron balls, no appreciable change in cyanide consumption occurred.

However, granting that finely divided metallic iron does consume cyanide, the solution of the problem, it seems to me, lies in removing the fine iron rather than by avoiding its formation by using a relatively inefficient grinding medium. No one suggests using flint pebbles in a ball mill for primary grinding, and rubber linings for such mills have not been successful. Flint pebbles in tube mills will not give over half the capacity for a given size of mill and equal fineness of feed and product.

Many years ago, at the Porcupine Crown mill, in Timmins, Ont., the idea was current that the capacity of the mill was reduced and power consumption increased by the iron in circulation, which had to be ground exceedingly fine before it could escape the tube-mill classifier circuit. The mine electrician designed and built a magnetic separator, which was installed to take the iron from the tube-mill discharge.

A great deal of difficulty was experienced with the separator, mostly, as I remember it, with the commutator and with the insulation of the magnets in the unloading position. But, with a good deal of grief, it was kept going long enough to demonstrate that there was no noticeable advantage in eliminating the iron.

With the present development of magnetic concentration, magnetic machines are probably on the market in stock sizes suitable for removing iron from a tube-mill discharge without any excessive upkeep. If not, a machine could be easily designed, provided a sufficient advantage could be shown for its use.

JOHN DIXON.

Kirkland Lake, Ont.

Test No. 1

Head Assay, Au, $65.87

	Ground With Lime		Ground Without Lime	
	Residue Assay Au, Dollars	Consumption NaCN, Lb. per Ton	Residue Assay Au, Dollars	Consumption NaCN, Lb. per Ton
Iron mill	5.79	3.6	6.61	9.4
Rubber mill	5.58	3.3	5.37	3.3

Test No. 2

Head Assay, Au, $76.68

	Ground With Lime		Ground Without Lime	
	Residue Assay Au, Dollars	Consumption NaCN, Lb. per Ton	Residue Assay Au, Dollars	Consumption NaCN, Lb. per Ton
Iron mill	5.58	3.6	6.20	10.0
Rubber mill	5.58	2.9	5.06	3.1

Alaskan Tin

To the Editor of "E.&M.J.":

Under "Consultation," on page 817 of your issue of Nov. 23, is an inquiry concerning tin concentrates, in replying to which you mention the Alaskan production and say that no information is available as to the names of the producers. I can provide this information, which is that tin is produced in the Hot Springs district as a byproduct of the gold placer operations, although for this season production was lower than usual. Messrs. Buck & Hansen are conducting the main operation producing tin at this time, although next season others will add to the production. This year three to four tons of tin concentrates were produced. Their tin content, as cassiterite, averages 53 to 56 per cent in tin as metal. The Northern Commercial Company handles most of the shipments from this district, all shipments now being made to Singapore. The address of the above named companies is Hot Springs, Alaska.

The principal Alaskan tin production is made from the Seward Peninsula. This season production will be about 60 tons or more of concentrate averaging between 70 to 75 per cent in tin as metal. The principal producer is George Waldhelm, Nome, Alaska.

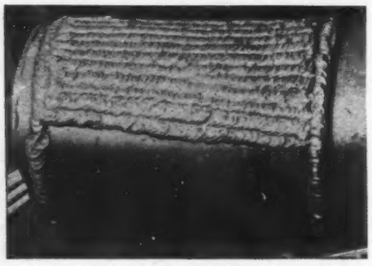
As all of the Alaskan tin concentrates are shipped to Singapore through Balfour Guthrie Company as brokers, I feel that the above-mentioned company would be interested in hearing from your inquirer. I might add that the production of tin concentrates in Alaska will be increased in the near future.

Los Angeles. N. L. WIMMLER.

Hard-Facing—An Aid to Economy at the Isolated Mine

MILES C. SMITH
Stoody Company, Whittier, Calif.

APPROXIMATELY seven years ago, Winston F. Stoody and his brother Shelley M. Stoody introduced to the petroleum exploration drilling industry a process which, for want of a better name, was designated as "hard-facing." The purposes of the process were twofold: to provide an economical method of rebuilding back to shape various types of oil-field tools which has become worn in service and a method of processing oil-field drilling tools so that they could better withstand



A shaft showing how the hard-facing overlay is applied.

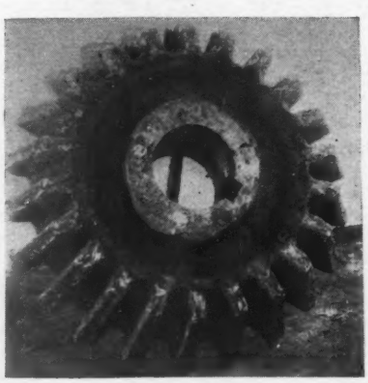
the ravages of abrasive wear in service. At the outset, the application of such a procedure was an experiment, but, in so relatively few years, the "hard-facing" process has been developed and has fulfilled the desired requirements to the point where it is considered largely responsible for present-day efficiency in the drilling of oil wells.

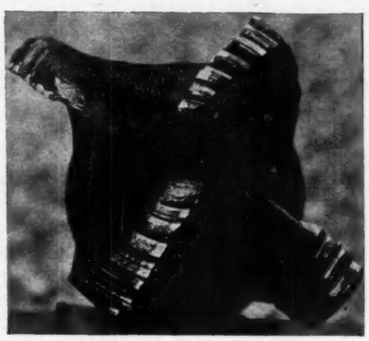
Hard-facing, as a process, is a branch of welding and consists in depositing an overlay of abrasive resistant metallic alloy over any desired metallic surface. The depositing is done with either the electric welding arc or the oxy-acetylene flame and the material used for forming the deposit is furnished either as a welding rod or as a welding compound. Furthermore, the process is applicable to any metallic surface which may be welded; the same general procedure precautions and preparation used in general welding procedure are quite applicable to hard facing.

With the general recognition of this process' success in the oil fields, that considerable research and experiment should be made in an effort to ascertain the possibilities of adopting the same or similar process in other industries was only natural. It was reasoned that other industries were hampered by the wear of abrasion, and if the oil-field drilling tools responded so well to such treatment, the machinery and equipment used in other fields of endeavor should be equally adaptable to such a preparation against wear. Naturally, metallic and non-metallic mining was included in the study. Investigation has proven conclusively that hard-facing, as a process, may be utilized in the mining industry with equal success to the outstanding results obtained in the petroleum drilling industry.

Hard-facing is a veneering or overlaying process and not one for building up large sections. It prepares a metallic surface better to withstand abrasive wear because it covers that surface with a veneer of extremely hard, abrasive resistant metallic alloy. Such alloys attain their hardness at the sacrifice of other properties equally desirable but not at present obtainable in extremely hard substances. A few of the overlay alloys developed thus far depend upon tungsten carbide for their hardness and abrasive resistant properties. Other alloys containing no tungsten attain the desired end by combining various elements such as chromium manganese, iron and silicon. In each case, the alloys, after being deposited with the electric arc or the oxy-acetylene flame, form an abrasive resistant deposit of sufficient inherent strength for an overlay, but of not sufficient structural strength to perform properly if used to build up large, unsupported sections. When it is necessary to build up such sections or replace a considerable amount of metal

Worn gear which has been welded back to shape and hard-faced.





Oil-field drilling tool which has been hard-faced, then placed in service and upon which the hard-facing metal is easily distinguished from the metal of the main body of the tool.

that has been worn away, the work should be done with other material, preferably high-carbon welding rod, and then the built-up section may be prepared against abrasive wear by overlaying it with the suitable hard-facing material or alloy.

As to the specific requirements of the mining industry, particularly those mines which are more or less isolated from normal sources of supply, hard-facing may be utilized and will be found one of the greatest adjuncts to economical operation as well as an insurance against shutdowns and delays. Properly applied, it lengthens the useful life of machinery and equipment and becomes an important method of handling repairs.

There is nothing mysterious or difficult about hard-facing, as a process, or about its methods of application. Anyone who can weld may apply hard-facing overlays with little or no instruction. The chief care is in selecting the proper hard-facing material or alloy to be used. No one hard-facing material has been perfected to date which would perform equally well under all conditions. Varying applications demand a wide variety of characteristics in the hard-facing overlay.

This fact is best illustrated by outlining the inherent characteristics, as well as the uses, of four overlaying alloys which cover the entire range of hard-facing applications. These are (so-called) Stoody Rod, Stoodite, Borod, and Borium.

Stoody Rod was the first hard-facing alloy developed by the Stoody Company and was the pioneer of all hard-facing materials. When melted down with the electric arc or the oxy-acetylene flame, it leaves a deposit consisting chiefly of manganese, iron, chromium, and a small amount of rarer metallic elements. The deposit is hard

Steam-shovel dipper tooth which has been hard-faced.

enough to resist ordinary abrasive wear, yet has considerable inherent strength and is not excessively brittle. Because it consists of relatively cheap metallic elements, it is economical to use and, although its deposit is not as hard as the deposits of many of the later developed overlays, it is much harder than hardened steel or iron and resists the wear of abrasion much better than either.

In relative hardness, as well as in relative marketing cost, Stoodite comes next. The deposit it gives, consisting chiefly of chromium, manganese, silicon, iron, and zirconium, together with a few rarer metals, is much harder than that referred to in the preceding paragraph. It is more brittle than the former overlay and sells for a higher price. It resists abrasion well under all conditions.

Borod, recently developed, is something quite different. When deposited, it consists of minute particles of tungsten carbide, cemented together by a large percentage of alloy steel. This deposit exhibits the characteristic resistance to abrasion of tungsten carbide, yet has alloy steel's resistance to fracture. Although relatively expensive to produce, this overlay is adaptable to services requiring high resistance to abrasion.

The fourth hard-facing material, Borium, is a cemented tungsten carbide, which possesses the qualities of industrial diamonds and is used instead of them. Neither the electric welding arc nor the oxy-acetylene flame will readily fuse this material, so it is applied by either brazing to the metallic surface or by welding it on with another welding material, preferably one which will itself resist abrasion.

Research and experimental work on hard-facing overlays has not stopped and new developments are coming to the front every day. However, the four products mentioned meet every demand of the present day and, particularly, of the mining industry.

In the mining industry, machinery and equipment are subjected to two basic kinds of abrasive wear: that caused by metal rubbing on metal and that caused by contact of the equipment with non-metallic substances of varying hardness. Either has little effect upon hard-faced surfaces. All hard-facings so far developed are sufficiently hard to decrease the friction heat as well as the wear of metal-to-metal surfaces and, furthermore, are unaffected if heated to any ordinary temperatures.

Hard-surfacing was developed to acquire a hard surface. Ordinarily, an overlay deposited by the welding arc or welding flame is relatively smooth, but in some instances the deposited surface will not be smooth enough for the specific application. In such conditions, the deposit may be ground to smoothness and, naturally, the harder the overlay, the more difficult it will be to grind it. This should be considered when an overlay is selected. Perhaps it will be more economical to sacrifice something in hardness to gain in grinding to smoothness.

Hard-facing is entirely practical as a maintenance process. It makes machinery replacements much less frequent and the time required for replacement much shorter. All that is necessary is to take the part out (in some instances this may not be necessary), weld it back to shape and hard-face it. What is still more important, this welding back to shape and hard-surfacing may be done again and again on the same intergral part with equal success. Once hard-facing has become well established in the mining industry, it will find fully as fertile a field for accomplishment as it has found in the petroleum-drilling industry, where it has brought about accomplishments and economies almost unbelievable.

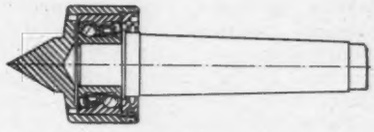
The Equipment Review

A BOX header being hydraulically riveted is shown in one of the illustrations on this page. The header shown is the new single-seam type, recently developed by Erie City Iron Works, Erie, Pa. The design is said to present the following advantages: It is possible to drive all rivets hydraulically, thereby giving a stronger, tighter and more perfect joint; there is only one edge to caulk, which reduces the chance of leakage; the single row of rivets is entirely out of the zone of fire and hot gas; and, finally, the method of suspending of front header permits all the rivets in the hanger to be out of the water or steam spaces. This is made possible by extending the hand hole sheet above the top row of rivets.

Riveting a single-seam box head hydraulically

For the Shop

A ball-bearing tailstock live center has been developed by the Ready Tool Company, Bridgeport, Conn. Some such device as this using anti-friction bearings is needed by reason of the greatly increased speed at which metal removing machines now operate. According to the company, this device is especially desirable for heavy work because of the pre-loaded condition of the bearing. The angular contact bearing has solid, high-carbon chrome-steel inner and outer races and is so assembled that the two rows of balls are opposed in a definitely pre-loaded condition.



Anti-friction bearings have been applied to this tailstock live center

Tongs for Hot Metal

Automatic safety tongs for handling hot billets or molds has been introduced by the Heppenstall Forge & Knife Company, Pittsburgh. Suspended from any kind of a hoist by a single rope, they are manipulated by means of this rope only and by the craneman alone without any auxiliary men, power or appliance. The tongs are normally open. A single down-and-up movement grips the load and a subsequent up-and-down movement releases it, leaving the tongs in the open position. This device is simply and strongly built.

A Manhole Exhauster

The Coppus Engineering Corporation, Worcester, Mass., has developed a manhole exhauster which has the advantage of sucking the air out of the boiler or tank, instead of blowing in the opposite direction. It weighs about 90 lb. and can be handled as easily as the company's manhole blower.

Choke Coils Found Useless in Lightning Protection

For more than thirty years it has been standard practice in the electrical industry to use choke coils in connection with lightning arresters for the protection of apparatus and transmission lines against damage caused by lightning and high voltage surges. Mathematical calculations showed, in general, that such coils assisted the lightning arresters by reflecting and retarding the incoming voltage waves.

Now, as a result of the development of the artificial lightning generator, the cathode-ray oscillograph or millionth-of-a-second camera and other new devices for the production and measurement of lightning-like voltage surges, the fact

has been determined that choke coils are not useful accessories to lightning arrester installations; and the manufacture and sale of such coils has been discontinued by one large manufacturer.

"Several mathematical studies of the action of choke coils on overhead circuits have been made, and there is a fairly general agreement on the methods of calculations," says V. E. Goodwin, of the lightning-arrester department of General Electric. "The equations have been based on certain assumptions regarding wave fronts and the instantaneous equivalent circuits and constants of the transformers and other apparatus. With certain assumptions it can be shown that the choke coil has merit; with other assumptions the reverse may be indicated. The assumptions were subject to too much uncertainty to make the mathematical treatments conclusive. Actual operating experience bearing on the merits of the choke coils has contributed nothing conclusive, some observations in practice seeming to substantiate and others seeming to oppose the prevailing theories.

"The true value of the choke coil could not be determined until exacting tests could be made on an actual transmission line. Development of portable lightning generators for creating known lightning transients on the line, and of portable cathode-ray oscillographs for recording the voltage current and time at any point of the circuit, have made possible a series of tests to define the performance of the choke coils with different transient wave forms imposed.

"These recently completed tests, using wave shapes corresponding to the range of actual lightning waves recorded during the last two years, show that the choke coil does not aid the performance of modern arresters and does not reduce the stress on the transformer or other apparatus, and under some conditions may even be detrimental to the service. The tests are quite conclusive, so that the choke coil is no longer considered as a useful accessory to any lightning-arrester installation."

INDUSTRIAL NOTES

Sullivan Machinery Company begins publication, with the November issue, of a new quarterly magazine, called *Engineering Graphic.* This replaces *Mine and Quarry,* formerly published by the same company, and well known to the mining industry, which has been receiving it since 1906.

Hill Equipment Engineering Company, of St. Louis, Mo., was recently organized by Lockwood Hill, who has been for the last ten years a member of the Blackman Hill Company, also of St. Louis.

Radiore Company of Canada, Ltd., has issued a bulletin entitled "Mining and Geophysics," reprinted from a recent issue of the "Southwestern Bulletin."

Truscon Steel Company announces the appointment of Gustave Kahn, formerly of the steel building products division, as sales executive of the pressed steel division.

BULLETINS

STEAM PLANT—Combustion Engineering Corporation, International Combustion Building, 200 Madison Ave., N. Y. City. Reprint entitled "Steam Pressures for Industrial Plants Determined by Rational Factors, by W. A. Shoudy."

LIQUID OXYGEN EXPLOSIVES—Keith Dunham Company, 110 South Dearborn St., Chicago, Ill. Reprint entitled "Liquid Oxygen Plant Supplies Quarries Near Chicago."

FLOW METERS—The Brown Instrument Company, Philadelphia, Pa. Booklet entitled "Why You Should Use Flow Meters."

CORROSION-RESISTING STEEL—Hadfields, Ltd., Sheffield, England. Bulletin No. 296; describes special corrosion resisting steel.

LIQUID-OXYGEN EXPLOSIVES—Keith Dunham Company, 110 South Dearborn St., Chicago, Ill. Booklet describing its product "Loxite."

LATHES—The Monarch Machine Tool Company, Sidney, Ohio. Catalog entitled "Monarch Lathes — Their Installation—Their Maintenance."

HEAT-RESISTING STEEL—Hadfields, Ltd., Sheffield, England. Bulletin No. 295, describing special heat-resisting steel.

ROCK, ORE AND GRAVEL HANDLING MACHINERY—Smith Engineering Works, Capitol Drive at Holton St., Milwaukee, Wis. General Catalog No. 266-F. This bulletin lists a complete and modern line of equipment for crushed rock and sand and gravel plants.

STEAM POWER PLANT—Combustion Engineering Corporation, International Combustion Building, 200 Madison Ave., N. Y. City. General Condensed Catalog GC-5. Fuel-burning and steam-generating equipment.

BLOWERS — The Connersville Blower Company, Connersville, Ind. Bulletin No. 123. Describes the Boston type of rotary positive blowers "RSB" and "RBB" series, medium capacities at normal pressures up to 10 lb. per square inch.

MATERIAL HANDLING—Robins Conveying Belt Company, 15 Park Row, New York City. Catalog No. 75 contains a full description of material handling equipment.

VALVES—The Chapman Valve Manufacturing Company, Indian Orchard, Mass. Catalog No. 61, describes in full the company's products.

MINE AND INDUSTRIAL SAFETY — The Mine Safety Appliances Company, Braddock, Thomas and Mead Sts., Pittsburgh, Pa. General Catalog No. 4 entitled "Everything for Mine and Industrial Safety." Among the products classified are: Edison electric safety cap lamps and accessories, Wolf gas- and air-measuring devices, oxygen breathing apparatus, a complete line of gas-mask respiratory protective equipment, gas detectors and recorders, resuscitation equipment, eye and head protective equipment, safety clothing, safety saws, and a complete line of first-aid supplies.

STOKERS—Combustion Engineering Corporation, International Combustion Building, 200 Madison Ave., New York City. Catalog GND-2, describing Green chain-grate stoker (natural draft.)

VALVES—The Chapman Valve Manufacturing Company, Indian Orchard, Mass. Book entitled "Coffin Products."

LUBRICATION — Alemite Corporation, 2646 North Crawford Ave., Chicago, Ill. Booklet No. 5 of Vol. 111, October, 1929, entitled "Alemite Industrial Lubrication."

WELDING — The Linde Air Products Company, 30 East 42d St., New York City. Booklet entitled "Oxwelded Piping," containing helpful and instructive information on the installation of oxy-acetylene welded piping for industrial uses.

EXPLOSIVES—Hercules Powder Company, Inc., News Bureau, Wilmington, Del. New publication entitled "The Labors of a Modern Hercules." The brochure consists of a series of articles by chemists, engineers, and officers of the company descriptive of processes and products.

SAFETY HATS—Bullard-Davis, Inc., 67 Wall St., New York City. Bulletin No. 801, describing hard-boiled hats and caps for mine and industrial head protection.

SHOVELS—The Thew Shovel Company, Lorain, Ohio. Pamphlet describing the new ¾-yd. Lorain 45 shovel.

MINE CARS—Joshua Hendy Iron Works, 200 Pine St., San Francisco, Calif. Catalog No. 201, describing Matteson cars.

SCREEN CLOTH—The Ludlow-Saylor Wire Company, St. Louis, Mo. Booklet giving complete reference data on doubled crimped wire cloth and woven wire screens.

CAR DUMPERS—Link-Belt Company, 910 South Michigan Ave., Chicago, Ill. Book No. 1004, describing rotary railroad car dumpers and illustrating the dumper in various positions.

QUICKSILVER SMELTING—H. W. Gould & Company, Mills Building, San Francisco, Calif. Bulletin No. 4, describing the latest improvement in quicksilver metallurgy, the improved cast-iron condensing system (centrifugally cast pipes).

RAILWAY ELECTRIFICATION — Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Booklet entitled "The Great Northern Railway Electrification," by Ralph Budd. The history and thorough description of the present distribution system, the locomotives, operation of the system, and maintenance of the locomotives and equipment are given.

SWITCHBOARD—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Circular 1825 on Type H busbar supports for indoor usage.

SWITCHBOARDS — Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Booklet C-1861, describing outdoor switchhouses with manual, motor, or solenoid-operated oil circuit breakers.

MAGNETIC CONCENTRATION—Dings Magnetic Separator Company, Milwaukee, Wis. Catalog No. 81, describing the principles of magnetic separation.

CLAY SPADERS — Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill. Bulletin No. 87-A. Describes the "M-1," 1929 model pneumatic clay spader. The spader weighs 25½ lb. and may be equipped with several different types of handles and throttles, including single and double grip handles, palm triggers, finger grip trigger, and push throttle handles.

DIAMOND DRILL—Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill. Bulletin No. 85-E. Describes Type "20" diamond core drill driven by gasoline engine.

ELECTRIC HEAT—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-261A. Illustrates the application of electric heat to groups of basic operations commonly found in industrial plants.

WELDING—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-876C. Type WD-400A are welder belt or motor drive.

WELDING—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-994A. Travel carriage for automatic arc welders.

Personal Notes

Ernest Gayford, of the General Engineering Company, has left Salt Lake City on a business trip to the East.

J. R. Hobbins, vice-president of Anaconda Copper Mining, has returned to Butte, Mont., after a recent trip to New York City.

H. L. Carr, assistant manager of the Mexican mining department of American Smelting & Refining at El Paso, is in New York City.

Lloyd C. White, consulting engineer for the Mexican Candelaria Company, in Sinaloa, Mexico, returned recently to San Francisco from Sinaloa.

Imer Pett, Sr., formerly general manager of Bingham Mines, has accepted the position of manager of Ross, Beason, & Company, of Salt Lake City.

Charles J. McIntosh, president of the Bank of California, has been elected a director of the Kennedy Mining & Milling Company, of San Francisco.

H. DeWitt Smith, assistant managing director of United Verde Copper, has been elected a director of Newmont Mining, succeeding **Stephen Birch,** who has resigned.

John G. Millhouse, of Litchfield, Ill., has been appointed director of the Illinois Department of Mines and Minerals, effective Dec. 16, to succeed **A. D. Lewis,** resigned.

William Strayer was elected secretary of the Eastern Oregon Mining Association at a recent meeting of the board of directors. He replaces **W. E. North,** who has resigned.

W. C. Smith, metallurgist for the Cerro de Pasco Copper Corporation, arrived in New York on Dec. 18, on the "Santa Maria," after spending five months at the plant in Peru.

G. M. Oldright, research metallurgist of the U. S. Bureau of Mines, Salt Lake Station, addressed the graduate seminar at the Montana School of Mines, in Butte, on Dec. 12. His subject was "Metallurgical Work of the Bureau of Mines."

Charles F. Courtney has been appointed managing director of the Sulphide Corporation, Ltd., operating in the Broken Hill district, New South Wales. The Hon. **Geoffrey C. Gibbs** has been elected to the board of directors to fill the vacancy created by the death of **F. A. Keating.**

W. D. Reynolds, of Bellingham, Wash., is in charge of operations at the Revenue Pocket gold mine, three miles from Gold Hill, Ore. **H. A. Ray,** of Medford, Ore., has the contract for driving the new workings at the mine, which is being reopened by a group of Bellingham capitalists.

F. H. Brownell, of the Copper Institute, New York, and vice-president of American Smelting & Refining, has been appointed to an advisory committee which will serve as a contact between trade associations and the executive committee recently authorized by the National Business Survey at Washington.

Philip D. Wilson, for two years general manager of the South African Copper Company, Ltd., operating in the O'Okiep and Nababeep districts of Namaqualand, is returning, after a visit to Northern Rhodesia, to the New York office of American Metal. Mr. Wilson will be succeeded in Namaqualand by **G. A. Kervin.**

W. H. BASSETT

M. E. Fisher, who has represented American Smelting & Refining as ore-purchasing agent in the Coeur d'Alene district of Idaho since 1902, will retire on Jan. 1, in accordance with the pension system of the company. Mr. Fisher, who has served for 34 years, was engaged at first in metallurgical work at smelting plants in Colorado. He will be succeeded by **Frank E. Johnson,** mining engineer, formerly at the Morning mine.

OBITUARY

Baron **Ludwig H. R. von Ruecau,** mining engineer, a resident of Colorado since 1870, died at the home of his daughter, in Denver, on Dec. 16.

Louis J. Krom, retired metallurgist and editor, died at his home in East Orange, N. J., on Dec. 23. Mr. Krom was born in New York City, 59 years ago. He was for many years metallurgist for the Chase Rolling Mills, at Waterbury, Conn. He was also managing editor of "The Metal Industry," for eleven years. He is survived by his widow and one son.

Firmin Desloge, prominent in the lead industry of southeast Missouri, died in St. Louis, Mo., on Dec. 18. Mr. Desloge, who was 86 years of age, was active in the affairs of his several mining interests until the time of his death. He was president of Desloge Consolidated Lead, which has been acquired by St. Joseph Lead, and of the St. Francois Investment Company. As a young man he took over the small lead enterprise, started by his father in Potosi, Mo., and developed it into one of the most important factors in the industry.

William F. Detert died in San Francisco, on Dec. 13, at the age of 79. He was one of the early California miners. Born in Germany, he came to the United States in 1866 and moved to California in the early 70's, establishing himself at Jackson, where he became interested in the Zeila, Argonaut, Kennedy, and Bunker Hill mines. He was at one time the owner of the Campo Seco copper mine, but later sold the property. He finally made his home in San Francisco, where he interested himself in power, banking, and mining. He was a director in various banks and also of the Kennedy Mining & Milling Company and of the Pacific Portland Cement Company. He was president of the Mayflower Gravel Mining Company, Golden West Oil Company, and the California Pacific Mortgage & Investment Company. Mr. Detert never married and is survived by a nephew, **Richard Detert.**

Bassett Nominated to Head A.I.M.E. in 1930

NOMINATIONS for the several officers of the A.I.M.E. during 1930 have been approved by the board of directors of the Institute. The nominations include W. H. Bassett for director and president; Henry Krumb and Scott Turner for directors and vice-presidents; and R. C. Allen, Cadwallader Evans, Jr., John M. Lovejoy, John A. Mathews, and Milnor Roberts for directors.

Mr. Bassett is technical director of American Brass, was formerly chairman of the Institute of Metals Division, has served on the board, and is now first vice-president and chairman of the executive committee. Henry Krumb, consulting mining engineer, was appointed to fill a vacancy on the board during 1928, and is now serving on the finance and endowment committee. Scott Turner, Director of the Bureau of Mines, is new to general Institute activities, but is a factor in the Washington section and was active in the Canadian Institute of Mining and Metallurgy while living in Toronto. R. C. Allen, of Oglebay, Norton & Company is a mining geologist and taxation expert. Cadwallader Evans, Jr., is general manager for the Hudson Coal Company at Scranton, and his election will bring back to the board representation from anthracite mining. John M. Lovejoy has served as chairman of the Petroleum division and is now president of Petroleum Bond & Share. John A. Mathews has been chairman of the old iron and steel committee, since made a division. He is one of the Hunt medalists and an officer of Crucible Steel. Milnor Roberts, professor of mining at the University of Washington, will represent the Pacific Northwest.

NEWS OF THE WEEK

Montana's Mines Closing Year of Increased Output and Profits

Higher Prices Stimulate Development as Well as Production in Butte and Outlying Districts—State Bureau of Mines Re-established and Now in Operation

CARL J. TRAUERMAN
Special Butte Correspondent

TAKEN in its entirety, the mining industry of Montana in 1929 has been prosperous, labor has been satisfied with the high wages and good living conditions, and stockholders of the leading companies have received substantial dividends. The 1929 Montana Legislative Assembly voted to re-establish the Bureau of Mines of the state, with a fair appropriation for carrying on the work under the supervision of Dr. F. A. Thomson, head of the State School of Mines. At present the bureau is carrying on work looking toward production of oil and metals and increasing the available supply of artesian water in the eastern end of the state. The U. S. Geological Survey has contributed its share this year in bringing up to date the survey of the Helena quadrangle, the work being done by J. T. Pardee and assistants.

Anaconda Copper established new production records during the year, according to John D. Ryan and Cornelius F. Kelley, respectively chairman and president of the company, who gave an outline of the work being done, in public utterances this summer. For six months of the year copper production from the Butte mines was the highest in the history of the company. Metal recovery from the ores was also the highest and the grade of ore was higher and reserves were larger than 25 years ago. Production has since been slightly curtailed. So satisfactory have been the profits from Butte operations that the management felt warranted in carrying on more than the normal amount of mine development work in the Butte district. This work has not been confined to Butte Hill, as considerable work is being done at the Anselmo group, near the School of Mines, and a deep shaft is being sunk on the Orphan Girl claim, with 2,800 ft. the objective. This work is in the western section of Butte.

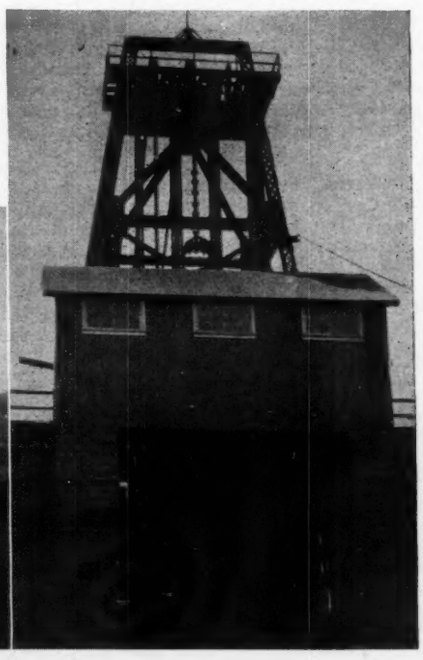
Butte & Superior has been producing zinc steadily throughout the year and paying, from a depletion fund mainly, its regular dividend of $2 per share annually. The principal news from the property was the opening of a new body of high-grade silver-zinc-lead ore on the 1,300 level, about 1,300 ft. north of its main shaft. According to the last report received from Daniel C. Jackling, managing director, work is going forward to tap this orebody on the 1,600 and 2,600 levels. During the last quarter of the year the company also slightly increased its production of copper ore.

North Butte Mining, after settling its legal difficulties, started actual mining on Butte Hill and is producing about 8,000 tons of copper ore per month therefrom. Besides this the company has unwatered its Main Range property, installed large pumps there, and now has crosscut to the eastern side of the Continental fault on the 2,200 level to pick up a body of rich copper ore found on the 2,000 level, east of the fault, several years ago. Diamond-drill holes are being driven to tap these veins and take care of the flush production of water that may be encountered. The new ore is expected to be opened before the end of January.

East Butte in the last quarter of the year declared a dividend of 25c. per share, the first declaration since 1919. In 1928 the company earned about 28c. per share, and it is estimated that the 1929 earnings were considerably higher. P. F. Beaudin, manager, is prosecuting an extensive development program on the lower levels of the mine and this has resulted in opening some rich copper orebodies, most of which have been extensions of orebodies found on the upper levels.

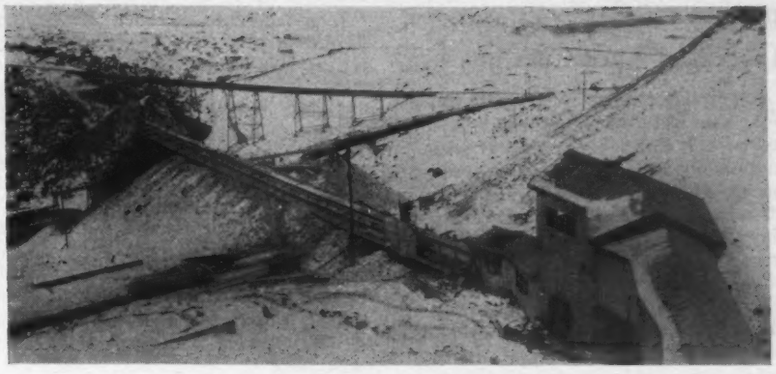
Butte Copper & Zinc Company has maintained its normal production of zinc-lead-silver ore from the Emma mine, in the heart of Butte. Development work at depth has shown good orebodies, especially when the large fault was cut below the 1,600 level. The gangue in the ore is mainly quartz and rhodochrosite, and the ore is readily concentrated with high recovery of metallic contents. The company is the largest producer of manganese in the West, and is now shipping steadily to

Two views of No. 4 headframe at East Butte

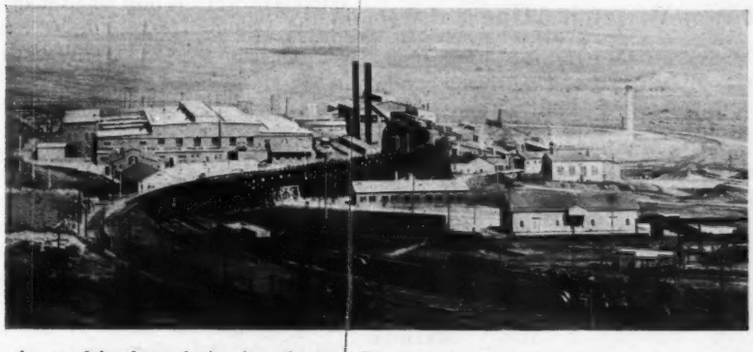


the roasting plant of Domestic Manganese & Development at Butte, where the rhodochrosite, with normal content of about 37 per cent manganese, is roasted to form a product assaying around 56 per cent manganese. This is shipped to Eastern steel makers. Butte Copper & Zinc paid a dividend of 50c. per share in December, the first in three years.

In the outlying districts of Butte, Butte Black Warrior and Bluebird Consolidated Mines are sinking shafts in the western area. Cotter Butte Mines is driving a tunnel to tap the Cascade vein in the northeastern section. In the southwest, or Ardsley, section, Ardsley Butte Mines Corporation is the only company that is active. Early in the year, several companies were active and capital was anxious to put money in to develop that district. However, many of the companies displayed poor business judgment in dealing with capitalists. As a result most of the southwest district mines are idle. Some of the companies are planning to sink deep shafts in that section in 1930, providing they can raise sufficient capital to do so.



Surface plant and conveyor to the railroad at Butte & Superior



Anaconda's electrolytic zinc plant at Great Falls

At the Washoe reduction plant, at Anaconda, and at the East Helena plant of American Smelting & Refining there has been little change in plant routine during the year. No immediate contemplated changes at either plant have been made public.

In the Philipsburg district, Granite County, manganese production slowed up a bit during the year, especially while the manganese tariff was in debate at Washington. The Trout mine of the Manhattan Electrical Supply Company, a large manganese producer and concentrator, opened a substantial body of silver ore and also purchased additional mining property.

In the Basin district, the principal operators are Basin Montana Tunnel, Comet Mines, and the Bullion company. Basin Montana Tunnel has opened three orebodies in the Grey Eagle and South Grey Eagle veins, these bodies being copper-silver; medium-grade zinc-silver-lead; and high-grade zinc-silver-lead, the latter being discovered in the last quarter of the year. The Grey Eagle property is opened on the 400, 500, and 600 levels and steady shipments are being made to the Washoe smelter and Timber Butte mill. The company has acquired about 1,700 acres on Comstock Hill, near Basin, and in 1930 will start driving a long tunnel to tap about 40 veins that have been opened and mined on the surface at depths of from 500 to 1,200 ft. The Bullion property has been acquired by Milwaukee mining men, who are building a 100-ton flotation plant and opening the mine. Comet is shipping from old orebodies above the 500 level. Silver Hill Mines is driving a tunnel east of the property of Basin Montana Tunnel. During the year the old Jib Consolidated company was reorganized as Basin Cataract Mining, and some work was done. However, not enough money was raised, and the company is now in a state of refinancing.

Northeast of Basin, Knickerbocker Mines is reopening the Bertha and Alta mines in the Wickes district. Both mines formerly were large producers of lead-zinc-silver ores.

In the Helena district the principal operators are Montana Mines, Metalsmith Mines, and Helena Silver-Lead. The latter is doing a limited amount of work in the Scratch Gravel district. Metalsmith has opened orebodies in the Marysville camp, carrying lead, silver, and gold. Metalsmith is planning erection of a flotation plant. Montana Mines Corporation owns valuable silver-lead properties near Winston, but its main work is being done at the Spring Hill property, in Oro Fino Gulch, about 4 miles from Helena. During the last year the company has opened large bodies of gold ore, the assays running from $5 per ton up. For over a month the mill heads were above $11 per ton. The company at first erected a 200-ton fine-grinding cyanide plant to treat its ores, but this has been changed to a flotation plant, now being enlarged to 400 tons, daily capacity. Orebodies at the Spring Hill mine are wide and cheaply mined and milled.

In the Radersburg district the foremost operation is at the Joe Dandy mine of the Butte Copper Consolidated Mines, the largest shipper of high-grade crude lead ore in the state. In the first ten months of 1929, the company shipped ore containing about 2,350,000 lb. of lead and 40,000 oz. of silver. The main shaft will be sunk below the 600 level, and the long south crosscut extended into the adjoining property, which the company holds under bond and lease.

In northern Montana, near Flathead, Anaconda and some leasers are shipping silver ore, assaying as high as 2,500 oz. per ton. Most of the work, so far, has been close to the surface.

Near Libby, the Zonolite Company is mining a phlogopite mica, which, when roasted, makes a product that is water-sound and fireproof and a good building material. The company has made several good contracts with users of this material, and in 1930 should mine as high as 500 tons per day and perhaps more. Contracts were made to net the company a profit of about $6 per ton.

In the Neihart-Hughesville district the principal operators are H. L. Maury, who is carrying on active developments at the Broadwater Consolidated property, at Neihart, and St. Joseph Lead, which is now on a steady operating basis at Hughesville, after a development program lasting two years under the direction of Frank H. Skeels. During that time the company opened its Block P mines on the 800, 1,000, and 1,200 levels and built a $200,000 concentrator. Output is about one car of lead and one car of zinc concentrates per day. The company is employing about 250 men, with monthly payroll of about $40,000, and has provided an adequate camp for its men.

Near Virginia City, Madison County, Ardsley Butte Mines is shipping high-grade gold and silver ore. The latest gold venture in the state is that of Gold Creek Dredging, which is installing a dredge to work the placers left from the old Pioneer gold workings.

British Columbia Output Increased 7 per Cent in 1929

AN INCREASE from $65,372,583 to about $70,030,976 in value is shown by British Columbia's mineral output in 1929, compared with 1928, according to an estimate made by J. D. Galloway, Provincial Mineralogist, and released by the British Columbia Department of Mines. This increase is equivalent to about 7 per cent. Actual metal production shows little change, however, the rise being accounted for by higher prices. A noticeable feature of the year's operations is that the total tonnage mined increased about 8 per cent, indicating the strides that have been made in treating low-grade ore. This is particularly true of the Britannia and Sullivan mines, where improved mining and metallurgical practice has greatly diminished the cut-off point between ore and junore.

Outstanding development work done during the year included the proving of a large body of low-grade silver ore at the Toric mine, near Alice Arm, by Howe Sound, and exposure, by open cuts, stripping, and a short tunnel, of a 100-ft. shear zone, 3,000 ft. long, containing lenses of high-grade copper ore on the Kinman property, at the northern end of Vancouver Island. Consolidated Mining & Smelting has optioned these claims. At the Old Sport mine, in the same district, this company has developed to a depth of 1,800 ft. on the dip of the vein. Machinery from its Rossland mines will be used.

Ingenika Mines, a company financed largely by stockholders in Premier Gold, has developed a promising silver-lead-zinc deposit in the Ferguson mine, Peace River region. Along the Tulsequah River two large complex orebodies have been opened up, 6 miles from tidewater. On the Tulsequah Chief, United Eastern Mining had done 1,000 ft. of tunneling and drifting and about 2,000 ft. of diamond drilling. About 120,000 tons of ore is reported to have been developed by this work between two levels so far opened. It averages 15 per cent zinc, 1 per cent lead, 2 per cent copper, 6 oz. of silver, and 0.1 oz. of gold to the ton. Alaska Juneau is developing a similar class of ore at its Manville group.

On the other side of the ledger, Topley Richfield and Kootenay King properties, which gave so much promise in the early stages, have failed to fulfill that promise by development done during the year.

New mills have been put into operation during the year by Base Metals Mines Corporation at Field, 300 tons, silver-lead-zinc; Planet Mines, Stump Lake, Nicola division, 125 tons, copper-silver-lead-zinc; Noble Five Mines, Sandon, 100 tons, silver-lead-zinc; Pioneer Mines, Bridge River, 125 tons, gold-silver; Silver Cup Mining Company, New Hazelton, 50 tons, silver-lead-zinc; and Reno Mines, Sheep Creek, 50 tons, gold. The remodeled mills put into operation were Galena Farm Consolidated Mines, 150 tons, silver-lead-zinc; Cork-Province, Zwicky, 150 tons, silver-lead-zinc; and Duthie Mines, Smithers, silver-lead-zinc, 75 tons. Construction still is under way on Hecla Mining Company's Union mill, near Grand Forks, 100 tons, gold-silver; Western Exploration Company's Mammoth, Silverton, silver-lead-zinc, 100 tons; and Pitt Mining Company's mill at Pitt Lake, near Vancouver, 100 tons, copper-silver-gold.

Dividends paid from mining operations during the year will total approximately $12,500,000, about $1,000,000 more than was paid from operations in 1928.

British Columbia Metal and Mineral Production, 1928-1929

Mineral or Metal	Production of 1928 Quantity	Production of 1928 Value	Estimated Production of 1929 Quantity	Estimated Production of 1929 Value
Placer gold, oz.	8,424	$143,208	7,706	$131,000
Lode gold, oz.	188,087	3,888,097	154,000	3,183,180
Silver, oz.	10,627,167	6,182,461	10,400,000	5,519,176
Copper, lb.	97,908,316	14,265,242	103,000,000	18,650,210
Lead, lb.	305,140,792	13,961,412	309,000,000	15,632,310
Zinc, lb.	181,763,147	9,984,613	180,000,000	9,750,600
Coal, long tons	2,526,702	12,633,510	2,313,900	11,569,500
Structural materials	.....	3,408,686	.....	3,880,000
Miscellaneous minerals and metals	.....	905,354	.....	1,715,000
Totals	.....	$65,372,583	.....	$70,030,976

Jacobs Engineering Builds Mill at Wasatch Mine

CONSTRUCTION of a 50-ton flotation plant at the Wasatch mine, now owned by Jacobs Engineering & Development, near Alta, Salt Lake County, Utah, is nearing completion. Lead concentrate will be produced. The plant is expected to be ready for operation by Jan. 15.

Equipment of the mill includes an Allis-Chalmers 9x15-in. Blake-type jaw crusher, a 6-ft. Hardinge ball mill, a Dorr classifier, a 6-cell, 50-ton capacity Denver Fahrenwald Sub-A flotation machine, a 14-ft. Dorr thickener, and a 48-in. single-disk American filter. Power for milling operations will be supplied by Utah Power & Light.

Officers of the new company are A. J. Crosier, president; A. J. Foutz, vice-president; and Charles B. Jacobs, general manager, all of Salt Lake City.

Seven Troughs Puts in Diesel

Installation of a 360-hp. Fairbanks-Morse six-cylinder Diesel engine is now proceeding at the Seven Troughs property, near Lovelock, Nev., where a new 100-ton mill is being built. The engine weighed 19,000 lb. and had to be hauled 27 miles over desert and mountain roads, according to L. A. Friedman, president of the company. Three 120-hp. Fairbanks-Morse Diesels supply the mine with power.

New Orebody Developed South of Messina Mine

DEVELOPMENT work south of the Messina orebody on No. 10 level of Messina (Transvaal) Development in the Zoutpansberg district, Transvaal, South Africa, has indicated a very large body of ore, according to J. P. Grenfell, chairman of the company, in a statement made to the annual meeting of the company. Development has indicated a length of 800 ft., with the face still in ore. Widths are said to range from 20 to 65 ft., and the grade is about 3 per cent copper. Development on the Nos. 8, 11, and 13 levels have indicated the orebody exists on these levels as well. The management expects that 200,000 tons will be proved for each 100 ft. of depth in this orebody.

Total known ore reserves at the Harper and Messina mines are estimated at 910,450 tons of 3.04 per cent copper ore. This is an increase of 168,286 tons over the figures for the previous year, in spite of the extraction of 225,299 tons during the year. Development work is also being undertaken in the Campbell area, in the southern part of the company's holdings.

Bureau's Polyhalite Tests Meeting With Success

A METHOD under which polyhalite is rendered completely soluble in water has been developed at the non-metallic experiment station of the U. S. Bureau of Mines at New Brunswick, N. J. Though the bureau has made no announcement as yet, it is understood that the mineral, when ground to a certain fineness, becomes slowly soluble—a quality that may make it a highly desirable fertilizer for direct application to the soil. Field tests now are under way in co-operation with several state agricultural departments. Polyhalite in its native state has been regarded as insoluble in water.

In the course of its drilling operations in the Southwest, the Bureau discovered two beds of polyhalite on public lands in New Mexico. Indications are that an important domestic source of fertilizer potash has been developed.

Report Soviet Searched Lena Goldfields Office

A dispatch to the New York *Times* from Berlin states that reports from Moscow declare that the G. P. U. (Russian Secret Police) raided and searched the Russian offices of Lena Goldfields, British mining company holding concessions in Russia. The raids are reported to have occurred on Dec. 14 and to have been made simultaneously on the company's four offices in Moscow, Leningrad, Sverdlovsk, and Bodaibo. Residences of the British managers at these points are also said to have been searched.

Ahumada Pumps Handling 3,000,000 Gallons Daily

INSTALLATION of a new 500-g.p.m. Allis-Chalmers pump was completed at the Ahumada lead property, Los Lamentos, Chihuahua, Mexico, early in November. Since then the mine has been handling about 2,600 g.p.m., or 3,000,000 gal. a day. Total capacity of pumping equipment is about 2,900 g.p.m. As a result of the installation, mining operations have been resumed on the No. 8 level, where most of the water is encountered. A small tonnage of high-grade ore was shipped from this level in November. Production of the property was about 1,200,000 lb. of lead both in November and in October, which is slightly better than it had been earlier in the year.

In extracting ore from the No. 8 level, hereafter, an effort will be made to avoid the fissures from which the water has been flowing. Considerable timbering is required also on this level, because of fracturing.

At the Erupcion mine, no ore was produced in November and only one carload in October. At present, work at this property is centered on exploration. On the No. 2 level, a crosscut is being driven to explore for the continuation of the orebody beyond a fault.

Mexican Corporation Reports Increased Sulphide Reserves

A LARGE increase in the sulphide ore reserves at its Fresnillo mine, in Zacatecas, Mexico, is the feature of the annual report of the Mexican Corporation. Hugh Rose estimates these reserves at 807,006 tons, on June 30, 1929, as compared with 477,860 tons last year. The ore contains copper, lead, zinc, silver, and gold. In addition 207,193 tons of ore was extracted. Further large increases in reserves are expected.

Only a minor amount of development work was done in the San Nicolas oxide orebody, with generally satisfactory results. Reserves are estimated at 2,073,000 tons, as compared with 2,757,979 tons last year. A total of 846,583 tons was extracted. The oxide ore costs were $2.31 per ton, of which $1.05 was for mining. The glory holes are now 300 ft. below the rims, and all ore and waste ore is hoisted in skips.

Ore reserves at the Teziutlan unit were more than doubled. On June 30, 1929, they were estimated at 128,000 tons averaging 3 per cent copper and 11 per cent zinc as compared with 55,000 tons of about the same grade last year. Production from this unit was increased somewhat, as new development has added greatly to the reserves.

First Crucible Delivered at Bunker Hill Smelter

THE FIRST of four steel crucibles that will incase the base of the four new furnaces being constructed at the Bunker Hill & Sullivan smelter, Kellogg, Idaho, has been delivered at the plant. These crucibles are being constructed by the Coeur d'Alene Hardware & Foundry Company at Wallace. The one just delivered is 14 ft. 2½ in. by 28 ft. 10½ in. by 4 ft. deep, inside measurement. Another of the same dimensions will be constructed. The other two will be 5 ft. longer and 18 in. wider. These crucibles are constructed of ⅜-in. sheet steel, the bottom being single sheet; the sides are double with a space of 4 in. between, forming a water jacket for cooling.

This crucible is designed to hold 275 tons of molten lead, as compared with 120 tons held by the crucible of the old furnaces. The two larger crucibles will hold 300 tons. The crucible weighs 11½ tons, and its delivery required adoption of unusual transportation. It was placed upon a specially built trailer truck with wide gage and long wheel base, and was drawn to its destination by one of the large G. M. C. motor trucks owned by the Wallace company. The distance from the Coeur d'Alene Hardware & Foundry plant to the Bunker Hill smelter is 11 miles, and delivery was made in less than an hour.

Silver King Coalition Completing New Thickener

Installation of a 120-ft. diameter Dorr traction thickener and a new pumping system at Silver King Coalition concentrator, Park City, Utah, is nearing completion. As will be seen from accompanying photographs, the tank, including the overflow launder, is an all-reinforced concrete structure with a structural steel Dorr traction mechanism, and will be used for supplying the heads of the zinc flotation circuit.

The new equipment will be in operation around the middle of January, 1930, it is expected.

The Silver King Coalition plant, with the new Dorr thickener

Transfer Veta Grande Miners to Other A.S.&R. Units

WORKERS formerly employed at the Veta Grande mine, Minas Nuevas, near Parral, Chihuahua, Mexico, have been transferred to other units of the Compañia Minera Asarco, American Smelting & Refining's Mexican subsidiary. The Veta Grande property, which employed 1,200 men and produced about 1,400 tons of silver ore daily, has been closed because of lack of power. The company's other Chihuahua properties have been affected only slightly by the power shortage resulting from lack of water at the Boquillas dam.

Construction of the new 300-ton plant at the Santa Eulalia property, near Chihuahua City, will be completed and the plant put into operation about the beginning of March. This plant will handle complex lead carbonate ores by flotation. No other new work of importance is being undertaken by the company in Mexico, except for the new shaft at the San Pedro unit, which is part of a program of expansion at that property.

Dos Carlos Now Principal Mine of Santa Gertrudis

EXHAUSTION of the El Cristo mine, and the short life in sight for the El Bordo and Malinche mines of Santa Gertrudis, Pachuca district, Mexico, have served to concentrate the company's attention on the Dos Carlos mine, where development has made important additions to ore reserves, particularly in the western section of the mine. Production from this source is expected to be very substantial. Of the total of 43,266 ft. of development work done by the company's subsidiaries, 30,506 ft. was driven in the Dos Carlos mine.

Notwithstanding the treatment of more than 633,000 tons of ore during the year ended June 30, 1929, reserves show a reduction of only 50,000 tons. Hugh Rose, managing director, places the total in sight at 959,000 tons of ore containing 14,500,000 oz. of silver and 61,700 oz. of gold.

Pyramid Finishes Headframe

Construction of the headframe and mill building at the Pyramid property, Eldorado County, Calif., has been completed, and equipment is now being installed in the 50-ton plant.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Dominion Transfers Public Lands to Provinces—New Shaft Planned at Frood

TORONTO, Dec. 21, 1929.—The Dominion of Canada has agreed to transfer the natural resources of the provinces of Manitoba and Alberta to the provincial governments. With the exception of Manitoba, Alberta, and Saskatchewan, all the other provinces own the natural resources within their boundaries. In these provinces all natural resources were owned and administered by the Dominion. For some years there has been no real disagreement over the fact that the provinces should have the resources, but they also demanded the same Dominion subsidy. Because the Dominion owned resources of these provinces, the Dominion was paid a higher proportionate subsidy than any of the provinces. The Dominion has finally agreed to return the resources and continue the present subsidies. The provinces agree to carry out the obligations entered into by the Dominion in respect to the sale or leasing of lands and of mineral rights.

INTERNATIONAL NICKEL will sink a new shaft at the Frood property, Sudbury, Ont., to a depth of 4,000 ft. and will equip it with the largest hoisting engines in Canada. The location of the new shaft has not been definitely decided, but development work on the lower levels has for some time indicated that another shaft would soon become a necessity. Not only the tonnage of ore, but the amount of materials and the number of men to be handled make it necessary to carry on the work efficiently. Indications now point to much greater lengths of ore than were originally expected. In driving east on the Frood Extension, which is the old Mond property, ore has been found right up to the boundary. East of this boundary International Nickel controls 3 miles of ground up to the Stobie mine, in which the possibilities are as yet entirely unknown. Though this ore is not as wide as it is to the west, the grade is high. Development work to date is said to have indicated ore of a somewhat higher average grade than was shown by the diamond drilling and that widths and tonnages are also greater than were indicated by the drilling. The fire at the Levack will cause a loss of 65,000 tons a month from this mine for the next few months, but this tonnage can be supplied with little trouble from the Garson, Creighton, and Frood. Several stopes at the Frood are already in condition for stoping and more are being rapidly opened up. When this mine is ready, it is expected to supply about 200,000 tons a month.

Abana Mines, at Dupuy, Que., requires $500,000 additional funds to complete the development program recommended by the manager, to erect a mill, and to provide working capital until the mine is on its feet. To raise this money shareholders will be offered the rights to subscribe for stock on the basis of one new share for each six shares held at a price of $1.25 per share. Stock not taken up by shareholders will be underwritten. The company has entered into a contract with the LaSarre Power Company, of LaSarre, Que., for the purchase of power during the life of the mine and construction of the power line has started. Electric power will be available April 1, and the construction of the mill will be started during the coming year. Recently diamond drills have cut ore at 800 ft. with good results. Drilling will also be done at 1,500 ft. and the shaft will be continued from 550 to 800 ft.

A recent report on the Greene-Stabell Gold property, in Quebec, recommends construction of a mill during 1930. Work during the last three months has been directed toward blocking out ore on the 150, 285, and 450 levels. This work indicates that the oreshoot is continuous to below 450 ft. Work has not progressed sufficiently to provide the basis for an exact statement of tonnage. Information obtained from experiments on the ore indicate that it can be successfully and simply treated by a combination of amalgamation and flotation.

Falconbridge Estimates Reserves at 1,367,000 Tons

WITHIN the area bounded by the underground workings, Falconbridge Nickel estimates that a total of 1,367,000 tons of copper-nickel ore has been proved at its property in the Sudbury district, Ontario. This estimate compares with one of 1,600,000 made after diamond drilling. The difference results from a pinching of the orebody between the 250 and 350 levels. Grade is estimated at 2.97 per cent nickel and 0.97 per cent copper. Little difference in grade has been noticed between the 225 and 1,000 levels.

On the basis of treating 250 tons daily, which is the capacity of the plant now under construction, an estimate has been made that cost of nickel production will be 20c. a pound, after crediting copper and precious metals. Profits would be about $656,000 annually. As soon as a market has been established for the products, however, operations will be stepped up to 500 tons daily. The smelter is expected to start some time in January, and matte should begin to arrive at the Norwegian refinery by the end of February. At this plant operation has been started on a small scale, according to recent advices, with expectations of having the nickel electrolysis in operation by the first of the year. Norwegian matte is being handled.

N'Changa-R.C.B.C. Merger Officially Denied

W. A. DOMAN
Special London Correspondent

LONDON, Dec. 10, 1929.—Rumors that the Rhodesian Congo Border intend to absorb its subsidiary, the N'Changa, in which it holds about a 40 per cent interest, are officially denied. The Congo Border concession covers an area of 52,000 square miles, and the N'Changa, which is contained within it, has an area of about 4½ square miles. With its huge untouched land holdings, the parent is much more likely to float off other concerns based on discoveries by prospecting. According to the Congo report just issued, a great deal of work has been carried out, and it has been established that the Bwana M'Kubwa series, which is the copper-bearing strata of the N'Changa district, is approximately 100 miles in length.

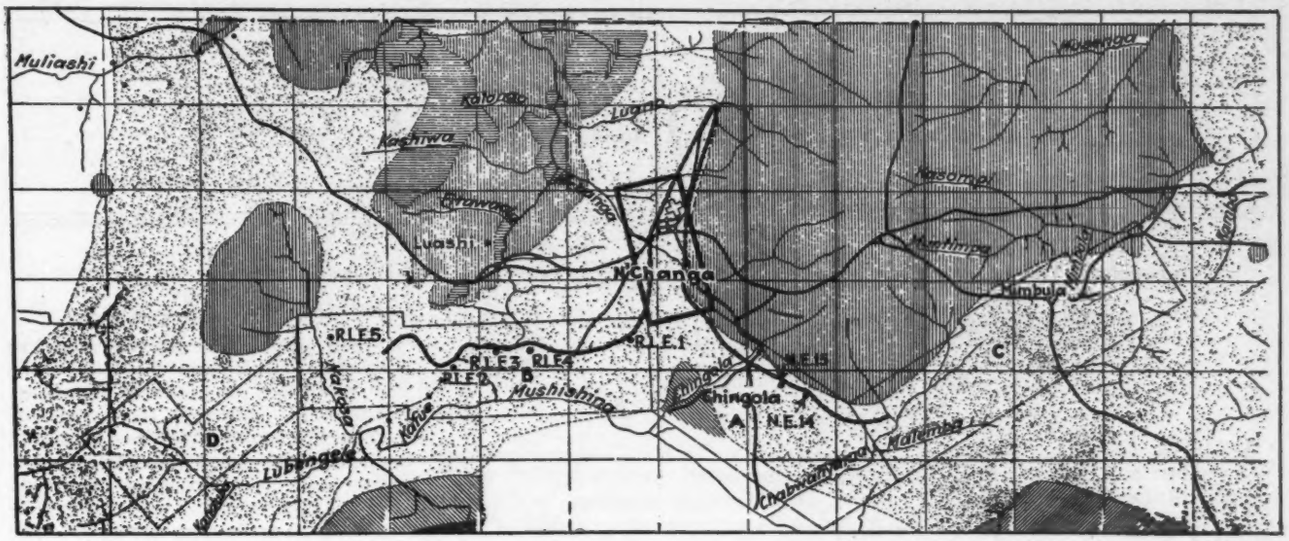
Novo Brdo Mines, a Chester Beatty concern, formed last year to prospect for minerals in Yugoslavia, is proposing to increase its capital from £80,625 to £150,000. Examination of ancient lead-zinc workings is thought to justify further expenditure.

Sir William Peel, chief secretary, in his budget speech before the Federal Council of the F.M.S., stated that the Malayan government viewed with apprehension the too rapid depletion of the country's tin resources and had taken the only rational course of checking the alienation of land for mining purposes. It is now stated that the government intends to introduce a six-day week for all laborers, which would certainly mean a big restriction of output. As the Chinese are themselves pressing for assistance, such a step would no doubt be effective, and thus the aims of the Tin Producers' Association would be accomplished without the assistance of that august body. Already the price of tin has risen sharply, and the share market is following suit.

Wenden to Build Mill

CONSTRUCTION of a flotation plant with a capacity of 125 tons daily and of a crushing plant to handle 500 tons will be started immediately at Wenden Copper, Cunningham Pass, Yuma County, Ariz., according to Ned Creighton, president of the company. Cost of constructing the plant, together with improvement of the power plant and necessary work in the mine, will total about $135,000, which will be financed by issuing long-term convertible corporate notes.

High-grade ore shipments have been made to the Hayden smelter for some time, but these will be suspended and all ore will be treated in the new mill hereafter. At the mine the company plans to connect the 400 level of No. 1 shaft with the 700 level of the Barkdoll shaft. Estimates place known reserves in the mine as sufficient for two years' operation of a 125-ton mill.



Geological map of Rhodesian Congo Border's holdings near N'Changa

LEGEND

- *Granites, younger and older granites mapped together.*
- *Middle Bwana M'Kubwa series the Chingola dolomite.*
- *Lower Bwana M'Kubwa series with felspathic sandstones and occasional intercalated beds of conglomerate at base, overlain in sequence by lower banded shales, sandstones and schists; felspathic quartzites and upper banded shales which at N'Changa are ore-bearing in places; and above these a great thickness of dolomitic schists and shales.*
- *Quartzites, sandstones, shales, and schists of Broken Hill series.*
- *Gabbro.*
- *Upper Bwana M'Kubwa series shales and sandstones overlying Chingola dolomite*
- *Geology not as yet determined.*

Note:- Co-ordinates approximate only

- *Boundary N'Changa Copper Mines Ltd.*
- *Outline N'Changa Syncline*
- *Boreholes*

Report Reveals Possibilities of Area Owned by R.C.B.C. West of N'Changa

Ore-Bearing Series Proved for Length of More Than 100 Miles in Rhodesian Congo Border Territory—Reserves Known in N'Changa Estimated at 59,000,000 Tons

GEORGE L. WALKER
Correspondent in London for Rhodesia

THE SEVENTH annual report of Rhodesian Congo Border Concession, Ltd., is accompanied by new geological maps which are of particular interest, as they outline the amazing situation that exists in the area west of the N'Changa property. The fact has been established that the ore-bearing series, in which remarkable values already have been proved by many boreholes at N'Changa, extends unbroken there for a distance of about 100 miles.

In a relatively small patch of the N'Changa property 59,000,000 million tons of ore, averaging 3.9 per cent copper, has now been proved. This and an examination of the map demonstrate the possibility that 600 million to 800 million tons may be eventually proved in a part of the vast area only 4 or 5 miles long—indeed within the area already roughly outlined by successful boreholes.

All developments and discoveries made by Rhodesian Congo Border are being studied constantly by its technical committee, which is made up of Sir Auckland C. Geddes (chairman), G. W. Gray, J. G. Lawn, E. H. Clifford, R. E. Palmer, P. K. Horner, and A. D. Storke. As Rhodesian Congo Border now owns 394,950 of N'Changa's 900,000 issued shares, and the companies jointly have thirteen diamond drills in operation and two large drills on order, a vast amount of technical work must be done. The underground development problems of both properties are being studied by this technical committee Power equipment essential to this operation has been ordered.

Arrangements have been made for the extension of the N'Kana branch line of railway to the N'Changa area, and work on it has begun.

During the year ended June 30, 6,700 square miles of the Rhodesian Congo Border area was systematically traversed, prospected and mapped geologically, 37 mineral occurrences being located and listed. Seven field parties have been assigned to scattered areas in the extensive western portion of the concession.

Late in the fiscal year a separate company, Kipushi Syndicate, Ltd., was organized by Rhodesian Congo Border, Sir Edmund Davis, and the Société Générale des Minerais to prospect an area of 10 square miles, to be selected from a belt 15 miles long and 5 miles deep in the portion of the Rhodesian Congo Border Concession extending along the Belgian Congo boundary near the Kipushi mine. Of this company's capital, Rhodesian Congo Border owns 53.3 per cent.

The immense tonnage of rich mixed oxide-sulphide ore, which now appears likely to be proved in the extension of the N'Changa deposit, may be expected to absorb the greater portion of the attention of the management for some time. Metallurgical work, as well as mining plans, is now being considered by the technical committee. From a reading of the report it appears that the work of prospecting and the geological mapping of the entire concession area of 52,000 square miles will be carried forward vigorously.

Rhodesian Congo Border has been provided with immense cash resources with which to carry out its great undertaking, and has acquired a technical staff which is capable of keeping the work going on along scientific principles.

Geophysical Companies Unite

The Swedish American Prospecting Corporation of New York has acquired all the shares of Aktiebolaget Elektrisk Malmletning (The Electrical Prospecting Company), of Stockholm, Sweden. By this purchase all electrical-prospecting operations carried on by this company in the eastern hemisphere will be directed from New York, although, for the present, the Swedish company's identity will be preserved and the Stockholm office maintained. These companies undertake electrical prospecting surveys of mineral land for ore and of petroleum fields for mapping structure. In the latter field, particularly, they work in co-operation with Seismos, Ltd., of Hanover, Germany, and subsidiary companies.

MARKET AND FINANCIAL NEWS

Slow Demand Important Factor in European Zinc Situation

INTERNATIONAL METAL SERVICE, LTD.,
LONDON

AS FAR AS zinc is concerned, November has merely added another chapter to the already long tale of woe. The trouble is now no longer mainly confined to Europe, but the American market—which for so long presented a firm front—has at last succumbed to the disintegrating influences of poor demand and the low level of prices.

The extraordinary feature of the present situation is that world production of zinc is not so much in excess of last year's output as to account for all the trouble which has been inflicted upon the zinc industry. Taking the American Bureau's figures, we find that world production of zinc for the first ten months of the year is estimated at 1,343,000 short tons, against 1,308,000 tons in the same period of 1928, an increase of about 2½ per cent. Even this is exaggerating the increase, as the German and Polish figures now include zinc dust, which was not included in last year's total. The United States output has increased by 13,000 tons, so that if we deduct the figures for zinc dust, we have an increase of about 12,000 tons for the rest of the world. American "shipments for export" have declined by more than 17,000 tons, so we are faced with the fact that actually there has been less zinc available for the rest of the world than in the first ten months of 1928.

In the United States the domestic deliveries to the end of October were 24,000 tons higher than the figures for a year ago, so that it will need something sensational if the figures for the full year are not to be better than in 1928. Stocks on consumers' hands are probably less than a year ago, and United States can be acquitted of any definite decline in consumption. As is the case in Europe, a good part of the trouble is undoubtedly due to the growing output of electrolytic zinc.

The final quotation in London for November shipment was no higher than £19 12s. 6d.—and it is necessary to go back some twenty years or so to find a price as low as this. At this level a price has been reached which permits the suppliers of ore in many cases to suspend deliveries, so that if a curtailment of output of metal cannot be agreed on by the smelters voluntarily, it may be forced upon them through sheer inability to obtain a sufficiency of raw material to enable them to continue operating on the present scale.

The committee appointed by the Cartel to try to devise an acceptable scheme for consideration at the next meeting of that organization has drawn up a plan which should be agreeable to the constituent members, according to reports. But, inasmuch as the chief stumbling block appears to be the question of non-European metal, it is difficult to see just how a lasting agreement can be reached unless it be world-wide in scope. It might be a different matter were supplies of ore at all limited—but unhappily this is not the fact. Take the Mexican output, upon which the Belgian and German smelters rely to some considerable extent for their supplies. Mexico, naturally, wants to smelt her own ores, and, if there were only enough to go round, this would mean that so much less material would be treated in Europe. But nobody supposes that the smelters in question will tamely submit to extinction in this way, and it is assumed they will try and get supplies elsewhere.

Assuming that on the question of production we are on the eve of better things, there is still the question of popularizing and extending the use of zinc, which problem will have to be faced. At the moment consumption appears to be below normal: British galvanizers are no happier than a month ago, and though India has shown just a shade more interest, demand for galvanized sheets from that quarter is by no means as good as it ought to be. Neither is the Continental rolling trade contented with the present state of business, though on his point it is of interest to record that Poland reports a good increase in the domestic consumption of zinc sheets. To take any definite view of the market for the next few months is an exceedingly difficult matter, but it would not be surprising to find that bottom has been touched.

World stocks of zinc on Dec. 1:

	Metric Tons
United States	57,200
Canada, incl. afloat	3,700
Germany-Poland	16,200
Belgium	10,200
France	2,200
Great Britain	2,600
Other Europe	3,100
Australia, incl. afloat	4,000
Far East	1,200
Elsewhere	2,000
Total	102,400

Huge Tin Smelting Combine Being Formed

A PROVISIONAL agreement for the merger of four of the largest and most important tin-smelting companies of the world, affecting about half the world's tin supply, has been made in London by the Anglo-Oriental, Patiño, and prominent members of the newly formed Tin Producers' Association. The companies in the merger are the Cornish Tin Smelting Company, the Eastern Tin Smelting Company, the Penpoll Tin Smelting Company, and Williams, Harvey & Co. Under the plan a holding company will be formed with an authorized capital of £5,000,000. Approximately £3,000,000 will be required to carry out the merger, the balance being held in reserve for future developments.

Creation of London Tin Corporation, Ltd., which will be the largest tin producer in the British Empire, by the absorption of four other large companies by the London Tin Syndicate, was announced in cable advices from London. The four companies combining with London Tin Syndicate are Tin Selection Trust, Ltd., London Malayan Tin Trust, Ltd., and two Nigerian producing companies, the Anglo-Bauchi Tin Dredging Company, Ltd., and Mongu (Nigeria) Tin Mines, Ltd.

Eagle-Picher Subsidiary for Mining and Smelting

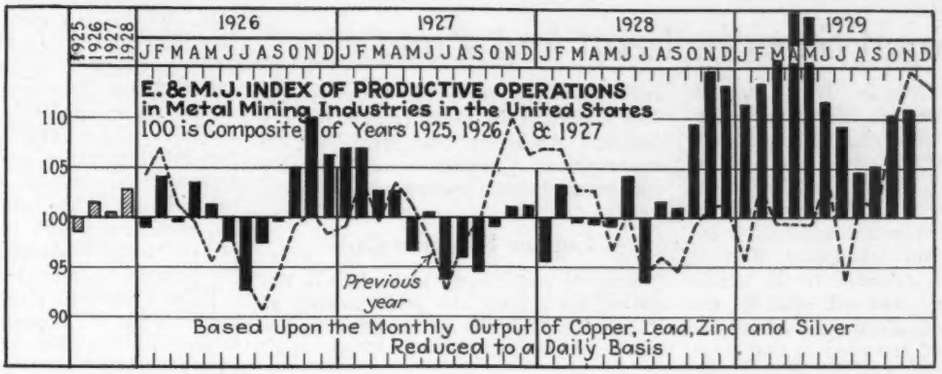
FORMATION of a subsidiary of the Eagle-Picher Lead Company to acquire the company's mining and smelting properties in the Tri-State district and include all properties of the Consolidated Lead & Zinc Company has been approved by the directors of Eagle-Picher. A special meeting of the stockholders has been called for Jan. 23 to vote on the proposal.

The new company will have a capitalization of $7,000,000. Formation of a subsidiary will enable Eagle-Picher to divorce its mining and smelting department from its manufacturing and sales department. Properties in the Tri-State area of Missouri, Kansas, and Oklahoma only will be included in new company.

RHODESIAN ANGLO AMERICAN, LTD., proposes to increase its capital to £3,500,000 by the creation of 2,000,000 shares of 10s. par, of which 1,500,000 shares will be offered to stockholders at £2 a share in proportion of three new shares for ten old. The issue will be underwritten by the Anglo American Corporation of South Africa, Ltd.

Indicators of Industrial Activity

of Significance to Mining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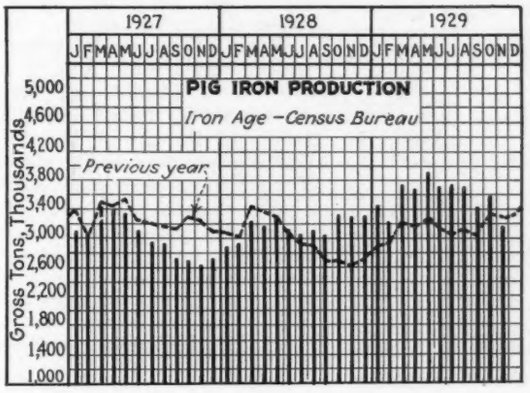
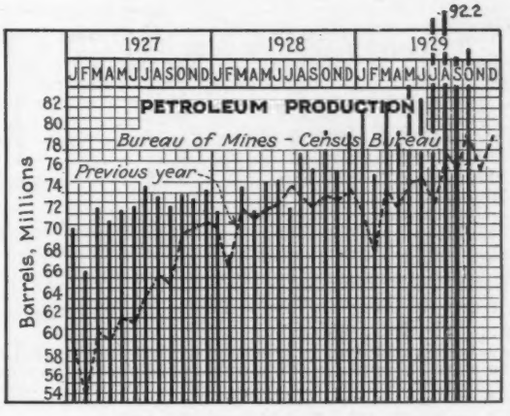
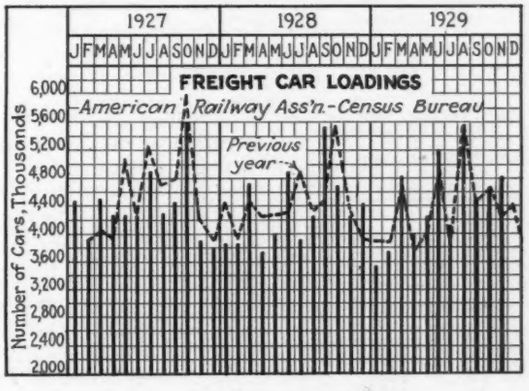
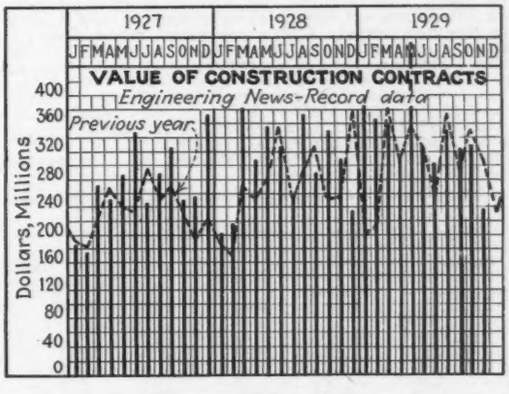
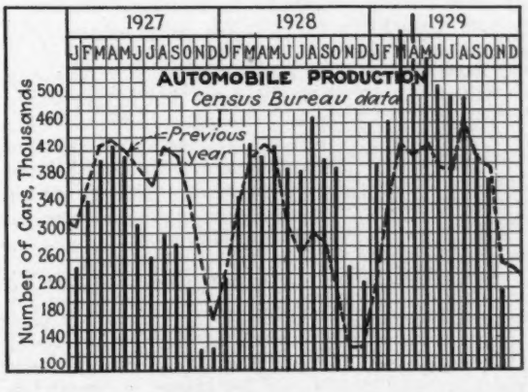
E. & M. J. INDEX OF PRODUCTIVE OPERATIONS
in Metal Mining Industries in the United States
100 is Composite of Years 1925, 1926 & 1927
110
105
100
95
90
Previous year
Based Upon the Monthly Output of Copper, Lead, Zinc and Silver
Reduced to a Daily Basis

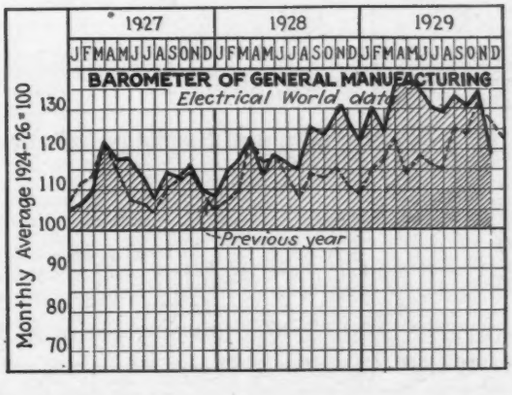











1927
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1929
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
BAROMETER OF GENERAL MANUFACTURING
Electrical World data
Previous year
Monthly Average 1924-26 = 100
130
120
110
100
90
80
70

The Market Report

Good Sales in Lead and Zinc

New York, Dec. 24, 1929—Demand for lead and zinc was fairly active during the week, but buying of copper continued at about the same slow rate as in recent weeks. The call for tin showed some improvement, a good part of the inquiry coming from the automotive industry. From the standpoint of price changes, interest centered in the action of silver, which sold off sharply, the London quotation moving to ½d. of the lowest price ever recorded in that market. The collapse of the Chinese pool was given as the chief reason for the decline. Antimony was offered at an easier price. Quicksilver was quotably unchanged, but the undertone was barely steady.

Copper Remains Dull

Scarcely any change took place in the market for copper, the price holding at 18c. delivered in the Connecticut Valley and at 18⅛c. in the Middle West. The sales total was slightly higher than in the preceding week, but this means little in view of the fact that the daily average was a little less than 400 tons for the period. The demand for fabricated copper has shown some improvement of late, and this is regarded as a favorable development, for it indicates that the actual consumer of the metal appears satisfied that the price is going to hold so far as early 1930 business is concerned. Of the small tonnage sold during the interval a good part was for December shipment. Generally speaking, the tone of the market is better than for some time, and much of this can be laid to the moderate improvement in the general industrial situation.

Export demand also remains far below normal, although new business booked in December has registered a gain contrasted with last month. Sales for export so far this month have totaled 16,000 tons. The export price was firmly maintained at 18.30c. per pound, c.i.f. usual European destinations.

World production of copper in November was 170,585 tons, against 175,540 tons in October and 183,813 tons in November, 1928, according to the American Bureau of Metal Statistics. World production for the eleven months of the current year was 1,970,996 tons, which compares with 1,737,231 tons in the similar period last year. Out of the total tonnage produced in the January-November period the United States is credited with 1,089,480 tons.

Daily Prices of Metals

Dec.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
19	17.775	40.50	6.25	6.10	5.45
20	17.775	39.625	6.25	6.10	5.45
21	17.775	39.50	6.25	6.10	5.45
23	17.775	39.50	6.25	6.10	5.45@5.50
24	17.775	39.875	6.25	6.10	5.45
25	Holiday	.....	....	....	....
	17.775	39.800	6.250	6.100	5.455

Average prices for calendar week ended December 21, 1929, are: Copper, 17.775c.; Straits tin, 40.542c.; New York lead, 6.250c.; St. Louis lead, 6.100c.; zinc, 5.475c.; and silver, 48.563c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East are 1@1.15c., depending upon purity, above St. Louis prices for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Dec.	Copper		Electrolytic	Tin		Lead		Zinc	
	Standard			Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
19	68 5/16	67 7/16	82⅝	183½	186⅜	21½	21 9/16	20¼	20 13/16
20	68⅜	67½	82⅝	179½	183½	21¾	21½	20⅛	20 11/16
23	67⅞	67½	82½	178⅝	181½	21¾	21½	20	20⅝
24	67 13/16	67 5/16	82½	180	183½	21 11/16	21½	20 1/16	20 11/16
25	Holiday	....	....	....	....	....	....	....	....

Prices for lead and zinc are the official closing prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Silver, Gold, and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
19	$4.87⅛	48⅜	22 3/16	84s 11 1/2d	23	$4.87¼	47½	21⅞	84s 11½d
20	4.87⅛	48½	22¼	84s 11½d	24	4.87 7/16	47⅜	21 1/16	84s 11⅜d
21	4.87⅜	48⅛	22 1/16	.....	25	Holiday	....	....	....

Average: Silver, 47.925c.; Sterling Exchange, $4.8744

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Lead Continues Firm

Though lead sales did not reach the volume of the week before, owing to a holiday let-up in demand, Thursday's and Friday's business was excellent, and the fundamental strength of the market continues. Prices are entirely unchanged at 6.10c., St. Louis, and 6.25c., New York basis, which latter is also the contract quotation of the American Smelting & Refining Company. No variation from these prices seems to exist in any direction, though for deliveries beyond January, producers are unwilling sellers, as they feel that should demand pick up after the holidays somewhat higher prices might be justified. One producer is already oversold for December and January, but no change is likely to be made in the current curtailed production rate until prices are somewhat higher.

Sales of lead for December shipment, to Dec. 23, were within 5,000 tons of the total for November, which is considered an excellent showing in view of the quietness that has prevailed in copper. Corroders and battery manufacturers have taken good tonnages, the demand for corroding lead being especially good recently. Not all of this grade is used for paint, however, as some goes into batteries.

Good Demand for Zinc

Good sales of zinc took place during the week at from 5.45c. to 5.50c., St. Louis, the bulk of the business passing at the low figure. Demand was even more active than in the preceding week,

with consumers in quite a few instances willing to book ahead for part of their first half of 1930 requirements. In fact, one transaction was noted in January-June metal, although few sellers cared to quote that far into the future. Most of the business placed was for January-March shipment. There were sellers of zinc at 5.45c. at the close. World production figures for November revealed a slight drop in output, the total for the month being 130,940 tons, against 135,937 tons in October and 131,555 tons in November of last year.

Tin Fairly Active

Consumers of tin entered the market for a good tonnage. In fact, the week was one of the most active that the domestic trade has seen in some time, and much of the buying was the result of a feeling that the metal at less than 40c. was a good purchase, especially since it is apparent that the industry is being strengthened from a production standpoint. A feature here was the greater call for tin from the automotive industry, indicating that business is moving into firmer ground in that direction. Sales of several hundred tons were reported today at 39⅞c.

London Silver Near Record Low

During the last week the silver market continued dull, with sagging prices in London which reached a level of within ⅛d. of the lowest price ever recorded. In New York the market suffered a sharp break of ⅞c., caused by lack of support and as a result of a further decline in China exchanges. The undertone is uncertain.

Mexican Dollars (old Mexican pesos): Dec. 19th, 35⅞c.; 20th, 36c.; 21st, 35⅞c.; 23d, 35½c.; 24th, 35⅝c.; 25th, holiday.

Foreign Exchange

Closing cable quotations on the principal Continental exchanges on Tuesday, Dec. 23, were: Francs, 3.94¼c.; lire, 5.23$\frac{13}{16}$c.; and marks, 23.965c. Canadian dollars, 1⅛ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands, 8¼c. per lb. for spot and 8⅛c. per lb. for future delivery. Demand continues quiet and prices were unsettled on freer offerings from China. Cookson's "C" grade spot, 14c.

BISMUTH—Per lb., New York, in ton lots, $1.70.

CADMIUM — Per lb., New York: 80@90c. Inside price named on contract business. Demand quieter.

IRIDIUM—Per oz., $200@$210 for 98@99 per cent sponge and powder.

NICKEL—Per lb., ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $35@$37. Small lots bring up to $46.

PLATINUM — Official price quoted by the leading interest on small orders for refined metal is $63 per oz. Transactions between dealers and refineries in the outside market are reported at several dollars less.

QUICKSILVER — Per 76-lb. flask, $121@$122. Small lots command the usual premiums. Demand moderate and prices unsettled. On contract business some sellers appear willing to make concessions.

Prices of Chromium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Titanium, Tungsten, Vanadium, and Zirconium are unchanged from the issue of Dec. 7.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $15.25@$15.50 for future shipment. Offerings moderate in near-by positions and prices are steady. Bolivian scheelite, $15.25, Dec.-Jan. shipment. Western scheelite, $16.50 for Jan. forward shipment.

Antimony, Chrome, Iron, Manganese, Tantalum, Titanium, Vanadium, and Zircon ores are unchanged from quotations in the Dec. 7 issue.

Tri-State Sales of Concentrate Up for Week

Joplin, Mo., Dec. 21, 1929

Blende	Per Ton
High	$41.40
Premium blende, basis 60%..	35.00
Prime Western basis 60%..	$34.00@ 35.00
Table concentrates, 60%....	32.00@ 33.00
Flotation concentrate	31.00@ 32.00
Average settling price.....	38.01

Galena	
High	$81.40
Basis 80% lead.....	$75.00@ 80.00
Average settling price.....	79.63

Shipments for the week: Blende, 9,965; lead, 3,082 tons. Value, all ores the week, $624,180.

Buyers of lead concentrate continue reporting the basis price as $75, yet 57 per cent of the shipments this week is known to have been settled for on a basis price of $80 per ton.

One more dollar was stricken from offerings for zinc concentrate, and producers accepted the reduced price at all Oklahoma mines. Buying last week and this week is of a larger tonnage than for several months. The shipment this week was not equal to the large purchase last week, the weather interfering. Mining operations were crippled, as concentration was unsatisfactorily conducted with icy water from frozen mill ponds.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Dec. 7 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Demand routine in character, but prices are holding firm.

SODIUM NITRATE — Per 100 lb., $2.12 for prompt delivery.

Antimony Oxide, Calcium Molybdate, Copper Sulphate, Sodium Sulphate, and Zinc Oxide are unchanged from prices in the Dec. 7 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $100. Spiegeleisen, 19@21 per cent, $34 f.o.b. furnace on carload business.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.45 f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferrovanadium, Nickel Silver, and Yellow (Muntz) Metal are unchanged from prices in the Dec. 7 issue.

Rolled Metals

Copper, lead, zinc, Monel metal, nickel sheets, and copper wire are unchanged from prices in the Dec. 7 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Dec. 7.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $19; basic, $18.50; No. 2 foundry, $18.50.

STEEL — Base prices per gross ton, Pittsburgh, billets and slabs, $35; plates, structural shapes, and soft steel bars, per 100 lb., $1.90@$1.95.

COKE — Per gross ton, Connellsville furnace, $2.65@$2.70. Connellsville foundry, $3.50@$4.85. Byproduct coke, Ohio and Kentucky (Connellsville basis), $6.50; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ended December 21, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda Copper	New York	80¼	70	72¼	Oc. 11 No. 18 Q	1.75
Andes Copper	New York	35¼	32¼	32¼	Oc. 11 No. 11 Q	0.75
Arizona Com	Boston	†1½	†1½	...	Jl. 16 Jl. 31 SA	0.25
Calumet & Ariz	New York	90	81½	82½	De. 6 De. 23 Q	2.50
Calumet & Hecla	New York	†33	†28½	...	No.30 De. 31 Q	1.50
Cerro de Pasco	New York	64½	59½	60¼	Oc. 10 No. 1 Q	1.50
Con. Coppermines	N. Y. Curb	6½	5½	5½	...	...
Copper Range	Boston	†15½	†14	...	De. 14, Ja. 15 Q	0.50
East Butte	Boston	†1½	†1½	...	No.20, De.21	0.25
Granby Con	New York	56¼	49½	51½	Oc. 18 No. 1 Q	2.00
Greene Cananea	New York	112	112	112	De. 12 Ja. 6 Q	2.00
Howe Sound	New York	41¼	37½	38½	De. 31 Ja. 15QX	1.50
Hudson Bay	N. Y. Curb	9¼	8¼	8¼	...	...
Inspiration	New York	31¼	27	28	De. 19 Ja.6 Q	1.00
Isle Royale	Boston	†13	†11	...	No.30, De.31 Q	0.50
Kennecott	New York	60½	54	56½	No. 29, Ja. 2 Q	1.25
Magma Copper	New York	53	47½	47¾	De. 30, Ja. 15 Q	1.25
Mason Valley	N. Y. Curb	....	....	2	...	...
Miami Copper	New York	29¼	26	26½	No. 1, No. 15 Q	1.00
Mohawk	Boston	†49	†44	...	Oc. 3, De. 2	3.00
Mother Lode	New York	2	1¼	1¼	De. 9, De. 31	0.20
Nevada Con	New York	32¼	27¼	28¼	De. 13, De. 31 Q	0.75
Noranda	N. Y. Curb	34¼	32¼	33	De.10, Ja.2 Q	0.75
Ohio Copper	N. Y. Curb	1¼	1¼	1¼	Sept., 1926	0.03
New Dominion	Boston	†7½	†6½	...	Dec., 1918	1.00
Phelps Dodge	New York	45	38¼	39	De. 6, Ja. 2 Q	0.75
Quincy	Boston	†20	†17	...	March, 1920	1.00
Roan Antelope	N. Y. Curb	28¼	25¼	25¼	...	...
St. Mary's M. L.	Boston	†26	†24	...	No. 29, De. 10	1.00
Seneca Copper	New York	2¼	2¼	2¼	...	...
Shattuck Denn	N. Y. Curb	9¼	8¼	8¼	...	...
Sheritt-Gordon	Toronto	3.05	2.70	2.81	...	...
Tenn. C. & C.	New York	13¼	12¼	12¼	No. 30, De. 16 Q	0.25
United Verde Ex.	N. Y. Curb	12¼	12¼	12¼	Ja. 2, Fe. 1 Q	1.00
Utah Copper	New York	....	....	2.40	D.13, De. 31 QX	8.00
Waite-Ack.-Mont.	Toronto	3.75	3.50	3.50	...	...
Walker Mining	Salt Lake	4.50	4.32½	4.32½	...	...
Wenden Copper	N. Y. Curb	*75	*62½	*75	...	...
LEAD, ZINC, SILVER						
Ahumada Lead	New York	*75	*50	*50	...	...
Amer. Z. L. & S.	New York	10	7¼	8¼	May, 1917	1.00
A. Z. L. & S., pfd.	New York	60	54	54	De. 12, Ja. 1 Q	1.50
Bunker Hill & S.	N. Y. Curb	101½	101½	101½	No. 29,De. 5 X	0.50
Butte Cop. & Zn.	New York	3¼	3	3	De.10, De.25	0.50
Butte Cop. Con	Boston Curb	....	....	31½	...	...
Butte & Sup	New York	5¼	4¾	5	De. 13, De. 31 Q	0.50
Callahan Zn-Ld	New York	1¼	1	1	Dec., 1920	0.50
Chief Consol	Salt Lake	1.85	1.80	1.85	Fe. 1, 1918 K	0.10
Consol. Ld. & Zn. "A"	St. Louis	6¼	5	6	Jan. 1930 Q	0.12½
Constitution	Spokane	....	....	*34	...	...
Dayrock	Spokane	....	....	2.00	Je. 20, Je. 30	0.03
Dickens Consol	Spokane	....	....	*4½	...	...
Eagle-Picher	Cincinnati	13½	13	13¾	De. 31,Ja. 15 Q	0.20
Eagle-Pich., pfd.	Cincinnati	....	....	101	De. 31, Ja. 15 Q	1.50
Erupcion	Boston Curb	....	†*6½	...	Jan. 1, 1928	0.07½
Eureka Bullion	Salt Lake	....	....	*46	...	...
Eureka Lily	Salt Lake	45	36	36½	...	...
Evans-Wallower	N. Y. Curb	4¼	3½	3¾	...	...
Evans-Wal., pfd.	N. Y. Curb	....	....	80	Je.20, Jl.1 Q	1.75
Federal M. & S.	New York	195	170	195	June, 1927	10.00
Fed. M. & S., pfd.	New York	97	97	97	No. 25, De.16 Q	1.75
Gladstone	Spokane	....	....	*1¼	...	...
Golconda	Spokane	....	....	*79	Je. 15, Jl. 1	0.02
Grandview	Spokane	....	....	*14½	...	...
Hecla Mining	N. Y. Curb	13½	13	13	No. 15, De. 15 Q	0.25
Highland-Surprise	Spokane	....	....	*6½	...	...
Jack Waite	Spokane	....	....	*7¾	...	...
Kootenay Florence	Spokane	....	....	*7¼	...	...
Lucky Jim	Spokane	....	....	*6	...	...
Lucky Tiger-C	Kansas City	....	....	†2.25	No. 9, No. 20 M	0.02½
Mexican Premier	Spokane	....	....	1.95	...	...
National Lead	New York	147½	133¾	133¾	De. 13, De. 31 Q	1.25
Natl. Lead, pfd. A	New York	140	139	139½	Nv.29, De.14 Q	1.75
Natl. Lead, pfd. B	New York	119	116½	118	Je. 17, Fe. 1 Q	1.50
N. J. Zinc, new	N. Y. Curb	70	67	69¾	No.20, De. 10 X	0.50
New Quincy	Salt Lake	1.35	1.00	1.07½	Se. 20, Se. 30 Q	0.10
Noble Five	Spokane	....	....	*41½	...	...
North Lily	Salt Lake	2.90	2.00	2.25	Oc. 16, Oc. 23	0.25
Park Bingham	Salt Lake	6	5½	5½	...	...
Park City Con	Salt Lake	*75	*75	*75	...	...
Park Utah	New York	3½	3½	3½	Dividends suspended	
Pend Oreille	Spokane	....	....	2.40	...	...
Rico Argentine	Salt Lake	*17	*15½	*15½	No. 30, De. 15 Q	0.03
Ruth-Hope	Spokane	....	....	*16	...	...
St. Joseph Lead	New York	56	47	50½	Se. 10, Se. 20 QX	0.75
Sherman Lead	Spokane	....	....	*48½	...	...
Silver King Coa	Salt Lake	10¼	9.85	9.85	De.15, Ja.2 QX	0.45
Silversmith	Spokane	....	....	5¼	Oct., 1926	0.02
Sunshine Mining	Spokane	....	....	4.50	De. 10, De. 20 Q	0.08
Tamarack-Custer	Spokane	....	....	*45½	Sept., 1924	0.25
Tintic Standard	Salt Lake	10½	10½	10¾	Se. 17, Se. 20 X	0.30
Tonopah Belmont	N. Y. Curb	....	....	*43¾	Oct., 1925	0.05
Treadwell-Yukon	Toronto	7.00	6.10	6.10	...	...
United Zinc Smg, New	N. Y. Curb	....	....	7	...	...
Utah Apex	Boston	†3¾	2¾	....	Oc. 15, No. 1	0.25
Utah Met. & Tun	Boston	†70	†60	....	Dec., 1927	0.30
Whitewater	Spokane	*18	*14	*16	...	...
Yellow Pine	Los Angeles	....	....	*8	Dec., 1925	0.04
GOLD						
Alaska Juneau	New York	8	6¾	7¼	...	...
Barry-Hollinger	Toronto	*15½	*13¾	*15	...	...
Central Manitoba	Toronto	*22	*19½	*19½	...	...
Cresson Consol	N. Y. Curb	*37½	*31½	*37½	De. 31, Ja. 27 Q	0.025
Dome Mines	New York	7¼	6¾	7	De. 31, Ja. 20 Q	0.25
Golden Cycle	Col. Springs	†15	†14½	....	No. 30, De. 10	0.40
Hollinger	Toronto	5.20	4.95	5.00	De.13, De.31 FW	0.05
Homestake	New York	79½	76½	76½	De.20, De.26 M	0.50
Kirkland Lake	Toronto	*50	*49	*49	...	...
Lake Shore	Toronto	19.65	19.25	19.25	De.2, De.16 Q	0.30
McIntyre Porcupine	New York	15	14½	15	Nv. 1, De. 2 Q	0.25
Portland	Col. Springs	†*7.	†*5	....	April, 1927	0.01
Rand Mines	New York	....	....	25	Au.21, 29 A.s.	1.50
Siscoe	Toronto	*48	*43	*44	...	...
Sylvanite	Toronto	*45	*40	*40	...	...
Teck-Hughes	Toronto	5.15	5.00	5.00	Ja. 17, Fe. 1 Q	0.15
Tom Reed	Los Angeles	*53	*50	*51	Dec., 1926	0.02
Unity Gold	N. Y. Curb	*68¾	*50	*50	...	...
Vipond Consol	Toronto	*65	*60	*65½	April, 1927	0.03
Wright-Hargreaves	Toronto	1.35	1.26	1.30	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	....	....	35¢	...	...
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	6	6	6	...	...
Castle-Trethewey	Toronto	*24½	*24½	*24½	...	...
Consol. Cortes	N. Y. Curb	....	....	*6½	...	...
Dolores Esperanza	N. Y. Curb	*18½	*12½	*12½	July, 1923	0.05
Keeley	Toronto	*35	*33	*33	Mr. 15, 1928	0.04
Mining Corp	Toronto	3.10	3.00	3.00	De. 4, De. 19	0.12½
Montana-Mines Corp.	Spokane	....	....	*31	...	...
N. Y. & Hond. Ros.	N. Y. Curb	....	....	16	De.18, De.28 X	0.50
Nipissing	N. Y. Curb	1¼	1¼	1¼	De. 31, Ja. 20 Q	0.07½
Premier Gold	N. Y. Curb	1½	1½	1½	De. 11, Ja. 4 Q	0.06
Tonopah Exten	N. Y. Curb	....	....	*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	....	....	2¼	Se. 30, Oc. 21	0.07½
United Eastern	N. Y. Curb	....	....	*18¾	...	...
Yukon Gold	N. Y. Curb	....	....	*50	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	95¼	87½	90¾	Jan. 18, Fe. 15 Q	1.50
Beth. Steel, pfd, 7%.	New York	123	122¾	122¾	De. 7, Ja. 2 Q	1.75
Cleveland-Cliffs	Cleveland	94	92	94	De.10, De.20 Q	1.00
Colo. Fuel & Iron	New York	39	32	33¾	...	...
Colo. F. & I., 1st pfd.	New York	....	....	126	No. 10, No. 1 Q	2.00
Great Northern Iron.	New York	22	20	20¾	Dec. 15 K	2.00
Inland Steel	New York	75	72	72	No. 15, De. 1 Q	0.87½
Republic I. & S.	New York	84½	70¼	74	No. 12, De. 2 Q	1.00
Republic I. & S. pfd.	New York	107	106	107	De. 12, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	45	45	45	Mr. 11, Mr. 20 Q	1.50
Sloss-Sheff. S.&I., pfd.	New York	75¼	75½	75½	De. 20, Ja. 2 Q	1.75
U. S. Steel	New York	174	158	163	No.30, De.30 QX	2.75
U. S. Steel, pfd.	New York	142	141½	141½	No. 2, No. 29 Q	1.75
Virginia I. C. & C.	New York	14¼	14¼	14¼	Jan., 1924	1.50
Virginia I.C.&C., pfd.	New York	40	39	39	Jl. 16, 1928 SA	2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	285	250½	274½	...	...
Alum. Co. of Amer., pf.	N. Y. Curb	109	108	109	De. 14, Ja. 1 Q	1.50
American Metal	New York	48¾	41¾	45	No. 20, De.2 Q	0.75
Amer. Metal, pfd., 6%	New York	112½	112¼	112¾	No. 20, De.2 Q	1.50
Amer. Sm. & Ref.	New York	75¼	69½	71½	Oc. 11, No. 1 Q	1.00
Amer. Sm. & Ref., pfd.	New York	135	134	134	No 1, De. 2 Q	1.75
Ang. Ch. Nitrate	N. Y. Curb	22	18½	18½	...	...
Asbestos Corp.	Montreal	2½	2½	2½	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	....	....	12	De. 31, Ja. 15 Q	1.75
Consol. M. & S.	Montreal	265	255	255	De. 31, Ja. 15 X	6.25
De Beers Consol.	New York	....	....	20½	Jl. 23, Jl. 26 Q	0.96
Federated Metals	N. Y. Curb	....	....	24½	De.20,De. 30 QX	0.50
Freeport Texas	New York	39¾	34¾	38¾	Oc. 15, No. 1 Q	1.00
Int. Nickel Can.	New York	31½	28½	29¾	No. 30, De. 31 Q	0.25
Int. Nickel, pfd.	New York	....	....	118	De. 28,. Fe.1 Q	1.75
Mayflower Assoc.	N. Y. Curb	51	48	49	...	...
Metal & Mining	N. Y. Curb	9¼	8¼	9	Se. 21, Oc. 1	0.30
Newmont	N. Y. Curb	121	108	110½	De. 27, Ja. 15 Q	1.00
Patino M. & E.	New York	31	27¼	29¼	De. 7, De. 24	4s.
So. America G. & P.	N. Y. Curb	1¾	1¾	1¾	...	...
Texas Gulf Sulphur	New York	57	52¾	53¾	De. 2, De. 16 Q	1.00
U. S. Sm. R. & M.	New York	37¾	34¾	34¾	De. 31, Ja. 5 Q	0.87½
U. S. Sm. R. & M., pfd	New York	53¾	52¾	53	De. 31, Ja. 5 Q	0.87½
Vanadium Corp.	New York	55¾	44¾	48¼	Nv.1, De.16 QX	1.75

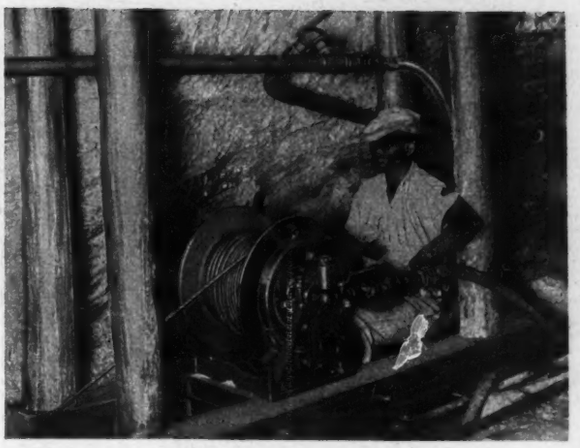
Toronto Standard Stock Exchange, Toronto, courtesy the Arthur E. Moysey Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company

*Cents per share. †Bid—asked range. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I Initial. R, Respumption. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend. A.s., American shares.

LONDON QUOTATIONS—WEEK ENDED December 10, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	12/6	12/6	12/6	...	...
Alaska Treadwell ($25)	60/—	60/—	60/—	Nov., 1926	4 p.c.
Aramayo Mines (25 frs.)	45/—	41/3	43/9	Nov., 1929	5 p.c.
Burma Corpn. (10 rupees)	16/10½	16/4½	16/7½	July, 1929	9 annas*
Bwana M'Kubwa (5s)	21/6	20/—	20/6	...	...
Camp Bird (2s)	1/4½	1/1½	1/4½	April, 1928	16⅔ p.c.
El Oro (5s)	2/6½	2/3	2/6	Nov., 1929	20⅚ p.c.
Frontino & Bolivia (£1)	7/9	7/9	7/9	Jan., 1929	3⅓ p.c.
Mexican Corpn. (£1)	11/—	10/7½	11/—	Oct., 1929	10 p.c.
Mexico Mines of El Oro (£1)	2/6	2/6	2/6	Dec., 1926	3⅓ p.c.*
Mount Isa (£1)	26/10½	26/3	26/3	...	...
N'Changa Copper Mining (£1)	40/—	33/9	36/3	...	...
Oroville Dredging (4s)	1/7½	1/7½	1/7½	Nov., 1928	31½ p.c.
Rhodesian Congo Border (£1)	147/6	132/6	135/—	...	...
St. John del Rey (£1)	17/6	17/—	17/—	Dec., 1929	2½ p.c
San Francisco Mines (10s)	26/4½	26/9	27/6	June, 1929	15 p.c.
Santa Gertrudis (£1)	12/4½	11/9	12/—	Jan., 1930	7½ p.c.
Selukwe (2s. 6d.)	4/6	3/9	4/—	April, 1917	6¾ p.c.
S. Amer. Copper (2s)	1/7½	1/1½	1/6	Nov., 1917	75 p.c.
Tanganyika (£1)	42/9	38/9	42/6	July, 1929	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	8,950	8,225	8,950	April, 1929	300 fr. (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francs and free of taxation.



Sullivan Turbinair Hoist (HA-2) Used for Pulling Cars in a South African Gold Mine.

Sullivan HDE-6 Double Drum Electric Hoist Hauling Cars in a Sewer Tunnel.

Pulling Cars Cheaply

"I want to pull a string of five cars, each holding 7 tons of rock 300 feet up a 2% grade—total load, 50 tons."

A 35 H.P. Sullivan "HE-4" hoist did the work, at 300 feet per minute. In a certain colliery, 20 Sullivan 7½ H.P. electric hoists are spotted at 20 points, to pull cars in to the shaft.

At a well known smelter, 7½ H.P. hoists have replaced yard locomotives in switching loads out and empties in.

These are a few of many car pulling jobs which Sullivan hoists are handling cheaply in many mines and quarries.

Sullivan hoists save labor and time. They save the expense of heavier equipment, prevent delays to costly haulage motors and locomotives, speed up production.

A Sullivan hoist may be set anywhere, to pull in any direction desired. It is easily handled, is compact and simple, no trouble to run.

The 7½ H.P. air or electric hoist will pull a 100,000 pound load on level track. Electric hoists are available in 7½, 10, 15, 25, 35, 50, and 75 H.P. capacities.

Sullivan hoists consume power only when they are doing work. Owing to simple and rugged construction, they show low upkeep costs.

Sullivan engineers will be glad to suggest a hoist of proper size and H.P. to meet your needs.

Ask for Bulletin 276-G.

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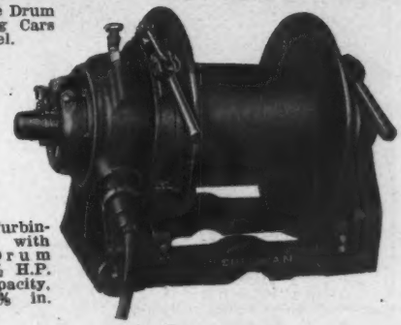


"HA-2" "Turbinair" Hoist with Large Drum Flanges, 6½ H.P. Rope capacity, 1500 ft. ⅝ in. cable.

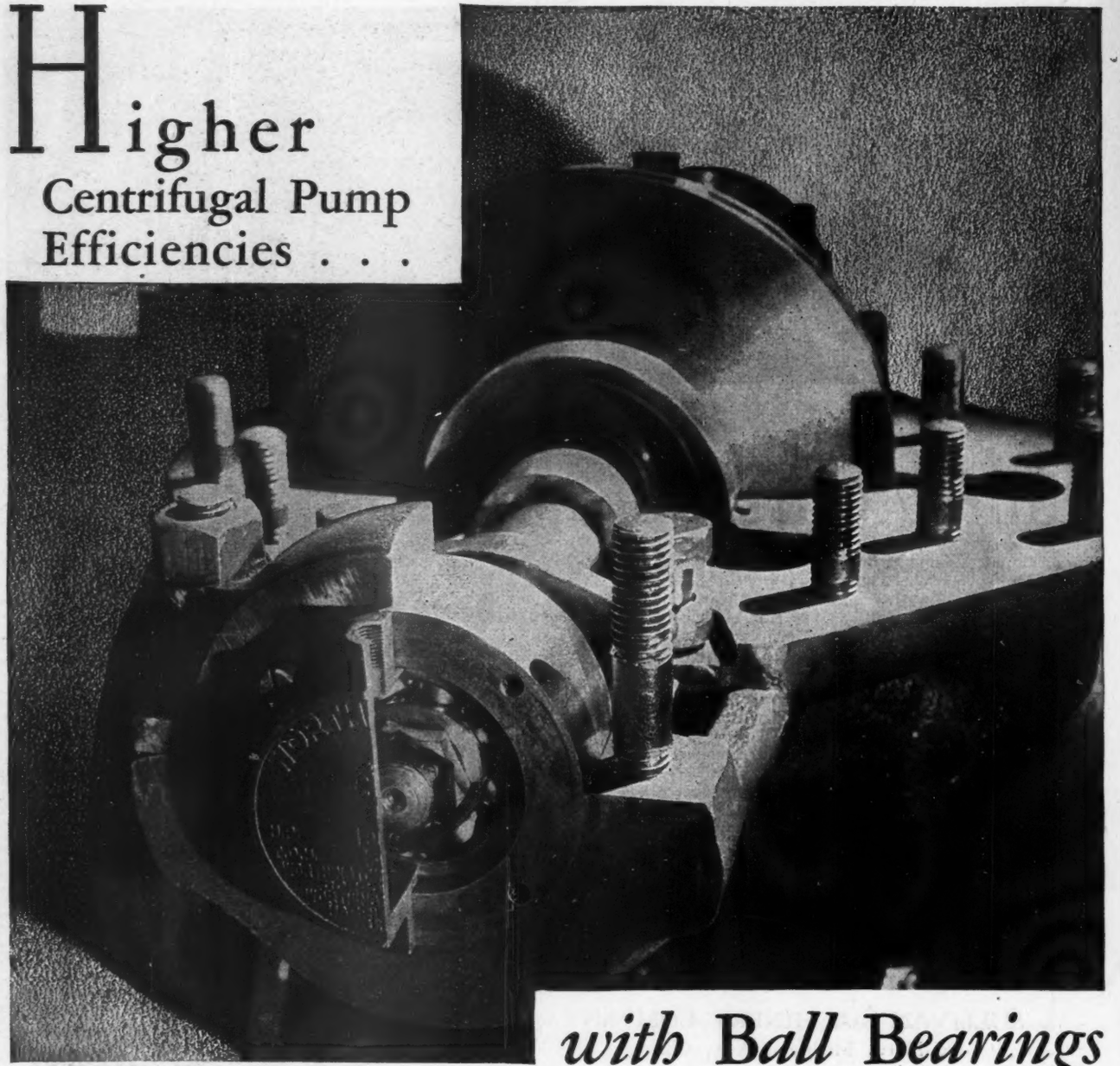
Sullivan HE-4, 25 H.P. Hoist, weight 2250 lbs. drum capacity 2200 feet, ⅝-in. wire rope.

Sullivan Portable Hoists

Four Sullivan "HE" Single Drum Electric Hoists are used at a Utah lead smelter for pulling the cars of hot slag and metal from the furnaces out to the main line, thus saving the time of yard locomotives in handling.

At the Dutch State Coal Mines at Limburgh, Holland, Sullivan "HE" Single Drum Electric Hoists are used at numerous points in the mine for hauling coal cars. The picture above was taken on the 391 meter level.

Higher Centrifugal Pump Efficiencies . . .



with Ball Bearings

THE cost, over an operating period, per 1000 gallons of liquid pumped . . . that, and not the purchase price, is the basis of figuring the expenditure for a centrifugal pump.

Worthington Ball Bearing Centrifugal Pumps attain the efficiencies that produce low pumping costs. The greater mechanical efficiency of the bearings is only a small part of the story . . . the use of ball bearings permits numerous features of construction that yield important hydraulic advantages.

Bulletin W-310-B1A contains a complete explanation and lists the entire line of these pumps. *Write for a copy.*

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F-45

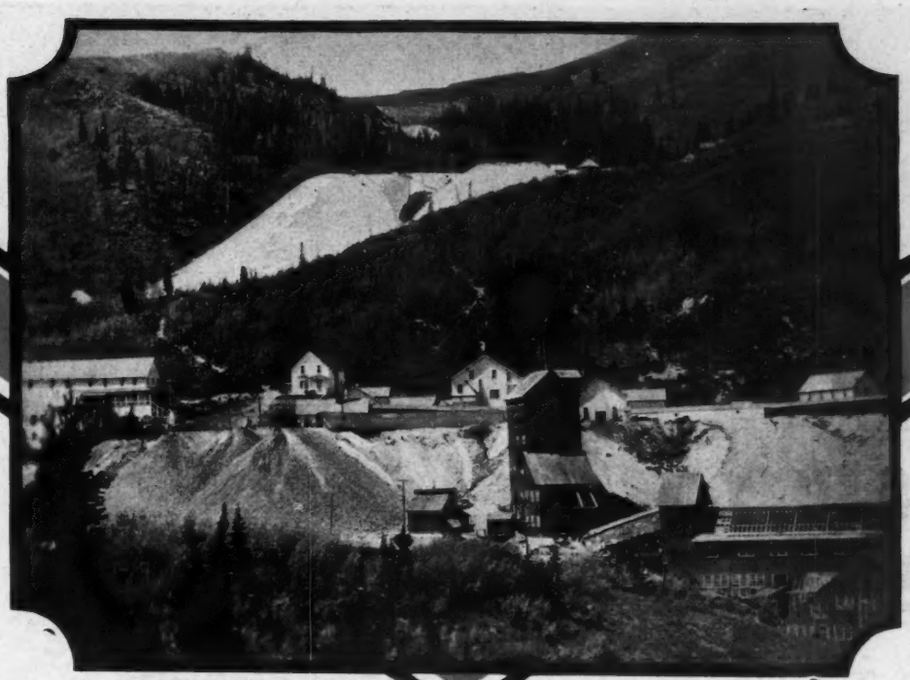

Photo of Daly West Mine (foreground) and Judge Mine (upper), Park City, Utah, properties of Park Utah Consolidated Mines Co., one of Utah's largest lead, zinc and silver producers.

"Daly West" and "Judge"— well known mining properties where CRUSCA DRILL STEEL

helps keep drilling cost at a minimum

Every mining man looking for a steel that will give him drilling speed, utmost footage, minimum breakage and fewest trips to the blacksmith, might consider the fact that Crusca "New Process" Hollow Drill steel is largely used by the foremost metal producers. A list of Crusca users could almost be termed the "Blue Book" of the industry.

For stoping, drifting, plugging, sinking and raising *in any formation* Crusca is the drill for your machines. Try it, and see how your drilling cost drops!

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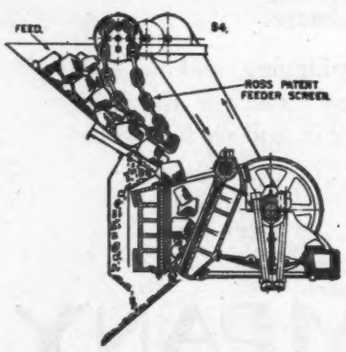
SETTING DRILLING RECORDS WITH CRUSCA

THE ROSS SYSTEM

ENSURES THE REGULAR MAXIMUM FEED TO YOUR CRUSHER THEREBY INCREASING PRODUCTION AND REDUCING OPERATING COSTS

Your crusher is designed to handle its maximum capacity at an even rate of feed. Fluctuating feeds may provide the desired production at the end of the day but only at the expense of intermittent overloads and—that way spells TROUBLE.



Feed your PRIMARY CRUSHER evenly; procure its maximum capacity without overstrain, even out the load on each succeeding unit of your plant and enjoy freedom from stoppages, heavy repair bills and high operating costs. The ROSS FEEDER will do this for you.

On the left is illustrated a typical installation showing a Ross Feeder combined with Grizzly to eliminate the fines from the crusher.

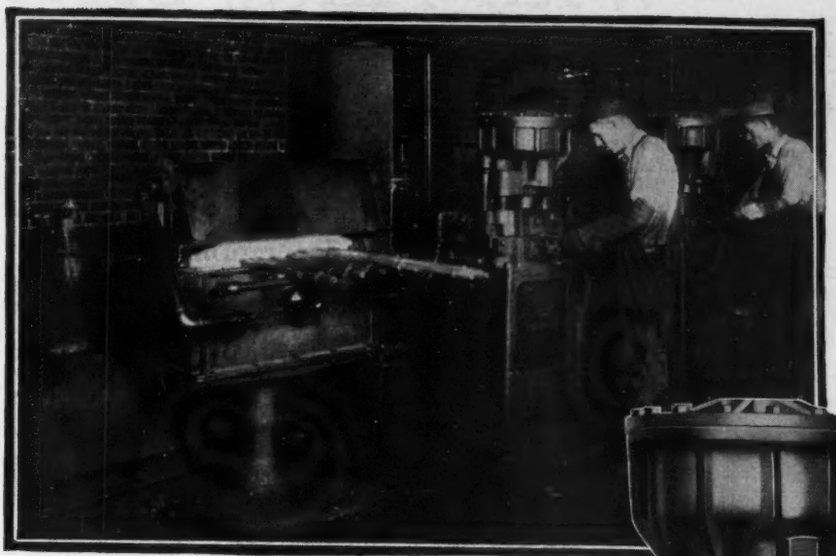
A fully descriptive catalog is obtainable from—

247 PARK AVENUE, NEW YORK CITY **SOLE MAKERS IN U.S.A.** Telephone—WICKERSHAM 1991
and at 2-8, Victoria Street, London, S W. 1, England. Telegrams and Cables—ROSPATENT, NEW YORK

THE ROSS SCREEN & FEEDER COY

For Sharp Drill Steel

Model DS-8 Sharpener



FOR many years the Model DS-8 has met all requirements of discriminating users of Drill Steel Sharpeners the world over. Although continually improved as time has gone by, no major or radical change has been necessary to keep this machine abreast of the times. The purchase of a Model DS-8 is equivalent to the purchase of perfect drill bits and shanks in large daily quantities at very low cost for operation and maintenance.

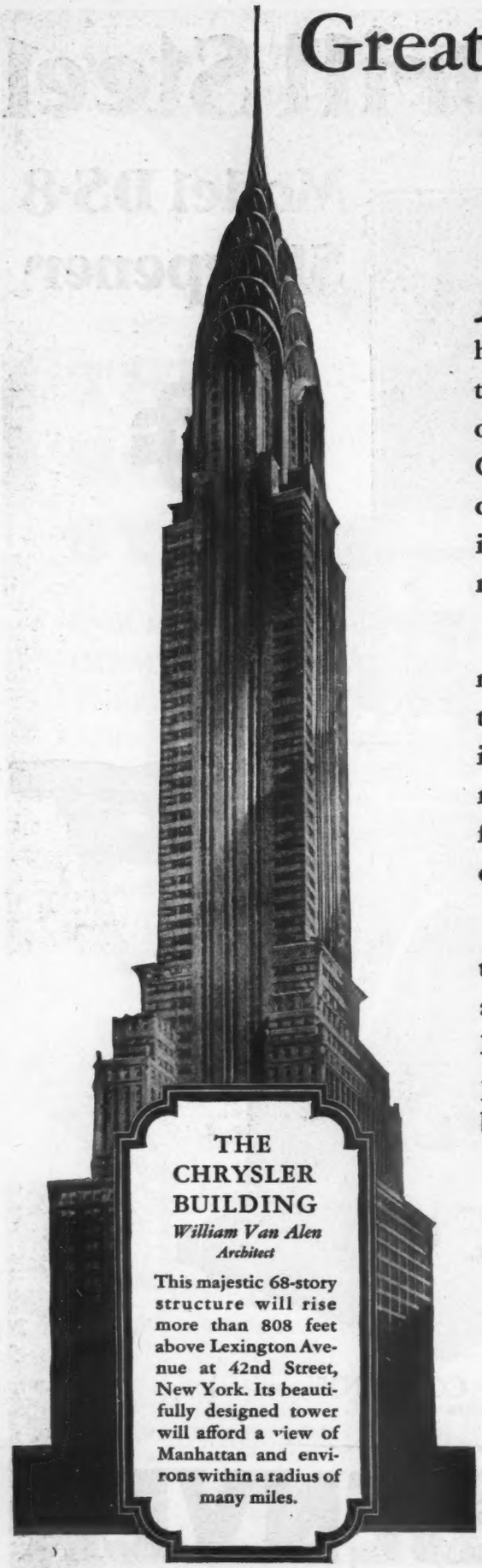
Combined with a Model HP-20 Bit and Shank Punch and supplemented by a Model DF-1 Oil Forge, the Model DS-8 makes an ideal installation where a large quantity of drill steel is required.

Write for Bulletin

GARDNER-DENVER COMPANY
ROCK DRILL DIVISION
DENVER, COLORADO
Sales Offices Throughout the World

GARDNER-DENVER

Greater Permanency With Alloy Steel



THE CHRYSLER BUILDING
William Van Alen Architect

This majestic 68-story structure will rise more than 808 feet above Lexington Avenue at 42nd Street, New York. Its beautifully designed tower will afford a view of Manhattan and environs within a radius of many miles.

A NEW alloy steel containing chromium has been found admirably suited for both exterior and interior metal decoration. Selection of this steel for the lofty tower of the new Chrysler Building and for the major portion of the exterior metal decoration emphasizes its adequacy in meeting the demand for permanency.

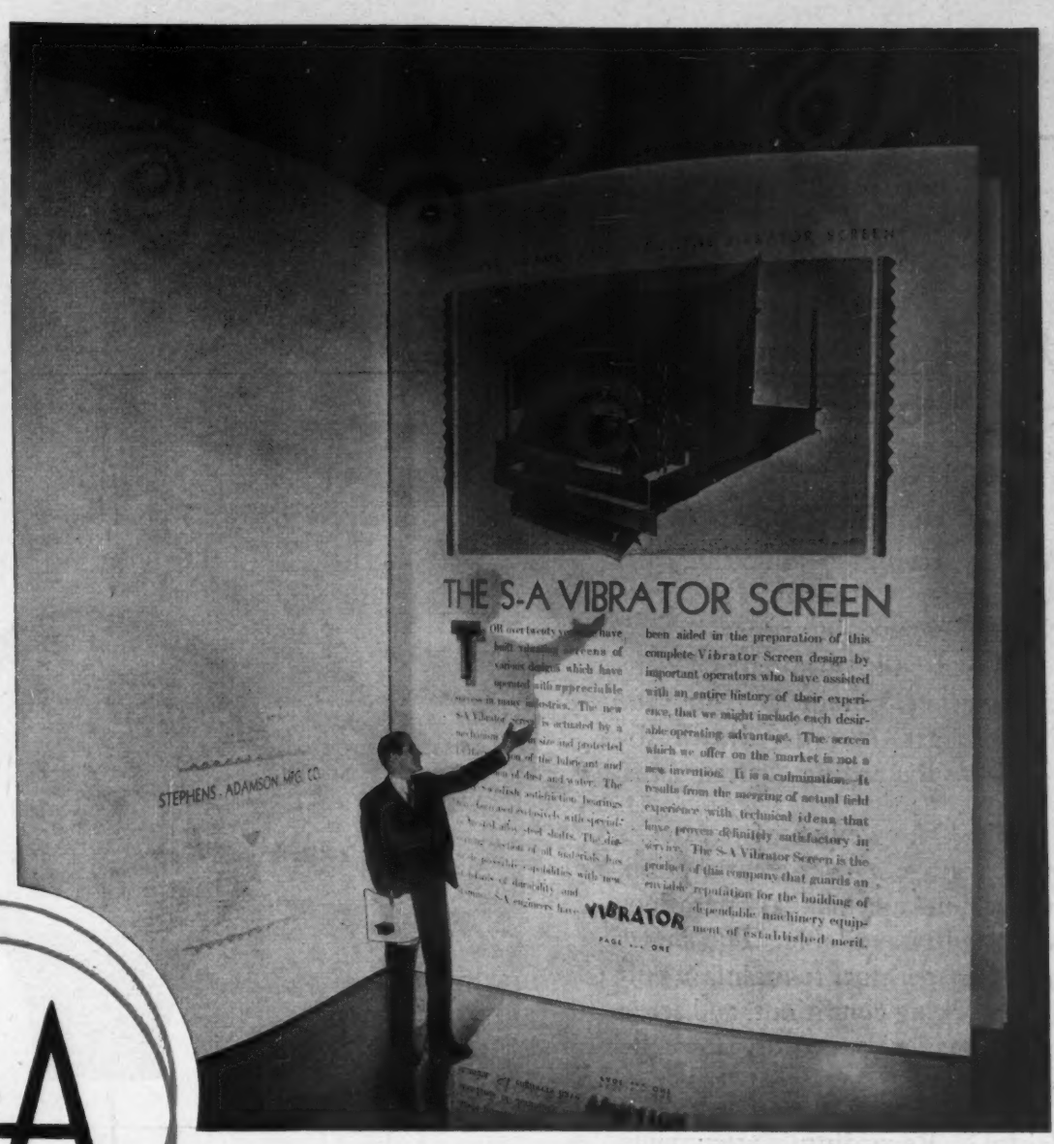
This steel shows complete resistance to atmospheric corrosion. It possesses the exceptional quality of retaining its color and luster; its surface does not tarnish; and, the metal being rustless throughout, there is no danger of surface deterioration, peeling, chipping or other change. It eliminates maintenance expense.

Increasing demand for permanent architectural beauty urges building designers to make a thorough investigation of alloy steel. Our Metallurgical Engineers shall be pleased to explain how the properties outlined above may be obtained from the use of ferro-alloys.

ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide UCC *and Carbon Corporation*
Carbide and Carbon Building, 30 East 42nd Street
New York, N. Y.

Electromet
Ferro-Alloys & Metals

VIBRATION POSITIVELY PRODUCED EFFECTIVELY ENDURED


THE S-A VIBRATOR SCREEN
been aided in the preparation of this complete Vibrator Screen design by important operators who have assisted with an entire history of their experience, that we might include each desirable operating advantage. The screen which we offer on the market is not a new invention. It is a culmination. It results from the merging of actual field experience with technical ideas that have proven definitely satisfactory in service. The S-A Vibrator Screen is the product of this company that guards an enviable reputation for the building of dependable machinery equipment of established merit.
STEPHENS. ADAMSON MFG. CO.
VIBRATOR

S-A VIBRATOR SCREEN

Sixteen important features will certainly interest every operator who requires screening facilities for large tonnages. Actual field experience and ingenious technical advantages have been merged to develop this dependable S-A Vibrator. The principle of positive vibration is fundamental with this screen. It is effected with a mechanism which will endure through long service life. All the interesting facts are told in an illustrated catalog which would be mailed at your request.

STEPHENS-ADAMSON MFG. CO.

AURORA, ILLINOIS ∴ LOS ANGELES, CALIFORNIA ∴ BELLEVILLE, ONT., CANADA

They depend upon their 47 BRISTOL'S Recording Instruments

To Keep Account of Important Smelting Operations—

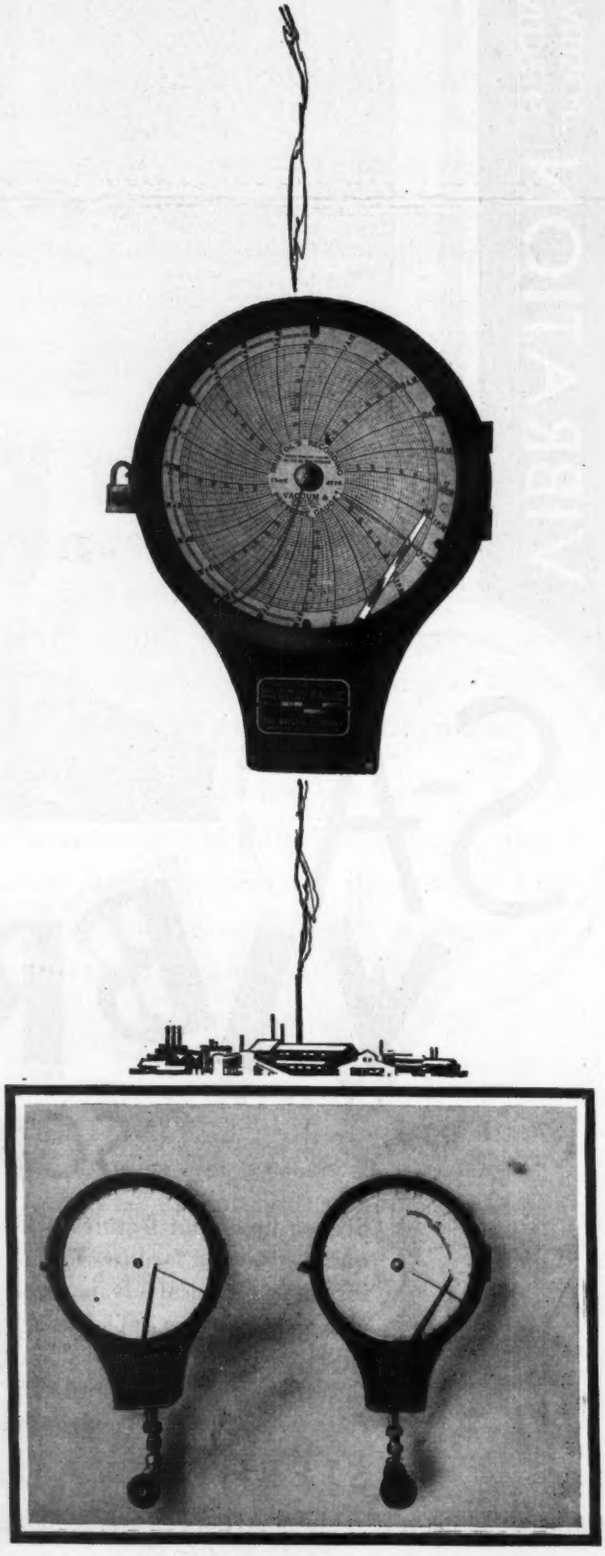
At the Irvington Smelting and Refining Company, Irvington, N. J., the operating supervision is simplified and coordinated by the information obtained from the daily chart records drawn by Bristol's Recording Instruments.

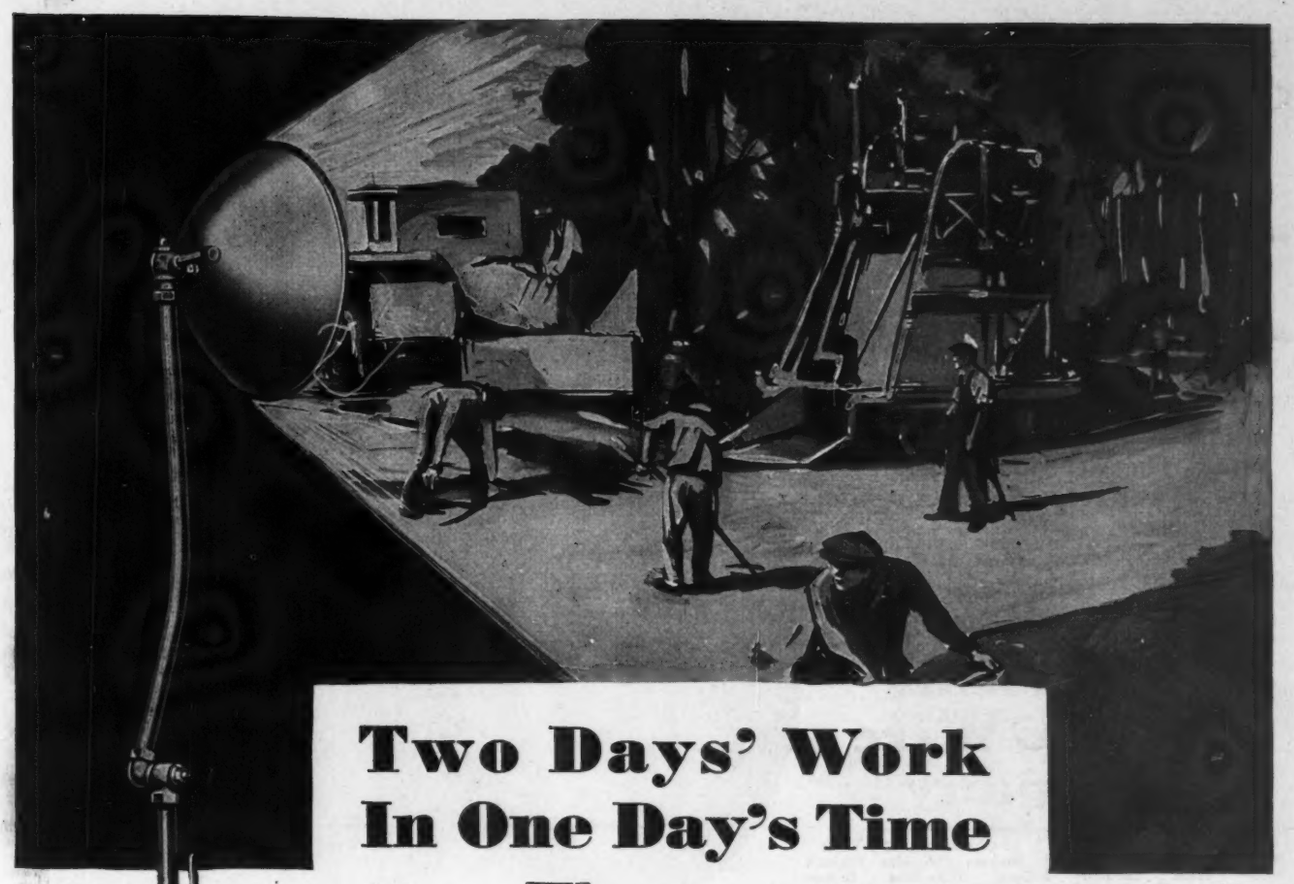
Definite knowledge of temperatures, voltage, power consumption, and various mechanical operations is constantly available. The charts help the operators to maintain efficient working conditions, and serve as permanent records for the executives.

Bristol's Recording Instruments are recognized throughout the mining industry as a dependable standard for accuracy. The simple design and rugged mechanical construction insure long enduring service with minimum maintenance.

The nearest Bristol's sales engineer will call at your plant upon request to analyze your Bristol's Recording Instrument requirements There is no obligation for this call. Interesting Bristol's catalogs are available. Write us today.

The
BRISTOL COMPANY
Waterbury, Connecticut





Two Days' Work In One Day's Time

Carbic is distributed by the Union Carbide Sales Company through its national chain of warehouses and is sold by jobbers everywhere.

WHEN days grow shorter—when dark hours crowd out productive operation—speed up your job with a night shift.

Carbic Flood Lights are powerful, portable units that supply clear white perfectly diffused light. They are rugged pieces of equipment built to serve you night after night.

Carbic Light requires no costly installation. Any inexperienced workman can charge it in a few minutes—and it is ready for hours of continuous service.

Carbic Light costs only a few cents an hour.

Extend Your Working Day With
CARBIC LIGHT

OXWELD ACETYLENE COMPANY

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CARBIC

PROCESSED CARBIDE FOR CARBIC LIGHTS & GENERATORS

Technical Publicity Department, **Oxweld Acetylene Company**
205 East 42nd Street, New York, N. Y.

Without obligation, I would like to have additional information on Carbic Lights.

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Another Reel of
American Wire Rope
-going into service

American Wire Rope is standard with all important mining operations. The dependable service it gives is well recognized throughout the industry.

See our nearest office and let our engineers assist in giving you wire rope for safety and economy.

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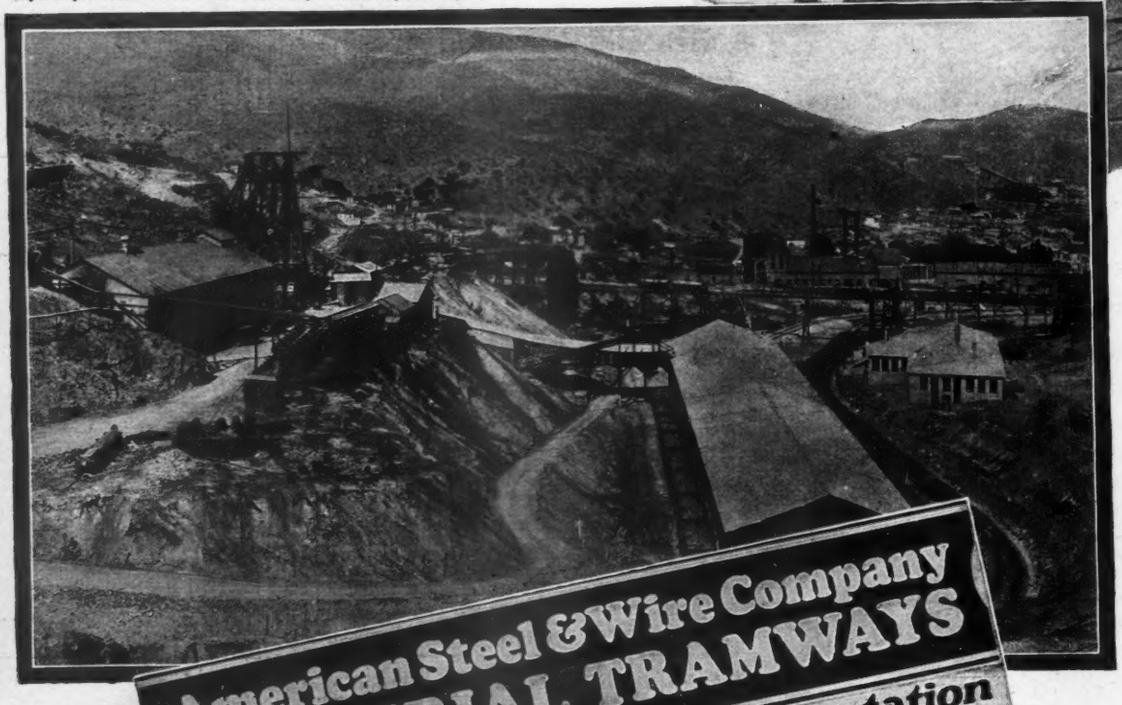

American Steel & Wire Company

Improved AERIAL TRAMWAYS

For Low Cost, Reliable Transportation

Here's how!-

To Turn the Rails on your Scrap Pile Into Real Money

HERE'S another way to cut costs! Don't junk bent or crooked rails. Put in a Watt rail bender and straightener. Make them as good as new.

It's just the device you've been looking for. Simple, fool-proof, compact. Portable or stationary as desired.

There's a lot of money lying on the scrap pile in twisted rails, simply because you have not had an efficient machine to straighten them. Now you have!

Here's What The Watt Rail Bender and Straightener Does:

Straightens any rail — bends rails to any radius — handles S curves or twisted rails in the mine (the rolls are double, no need to turn rails end for end, just flip them over) — enables you to bend your own turnouts. Does many odd bending and straightening jobs around the mine.

It is reasonably priced, reduces labor, is economical to operate.

Jot down your name and check the information asked for on the coupon.

Get your request for a quotation in now!

THE WATT CAR & WHEEL COMPANY
BARNESVILLE, OHIO

The Watt Car and Wheel Co., Barnesville, Ohio

Gentlemen—

Please quote us on your Rail Bender. We have rail weights in service as checked:

| 8 | 12 | 14 | 16 | 20 | 25 | 30 | 35 | 40 |

(Be sure to check weights)

Phase ..... Permissible .....
Voltage ..... AC or DC.....
If portable.....
Cycle ..... Track gauge is.....

Name.....
Company.....
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BUTLER

READY-MADE

STEEL BUILDINGS

AIRCRAFT FACTORY . . READY-MADE STEEL AND BRICK

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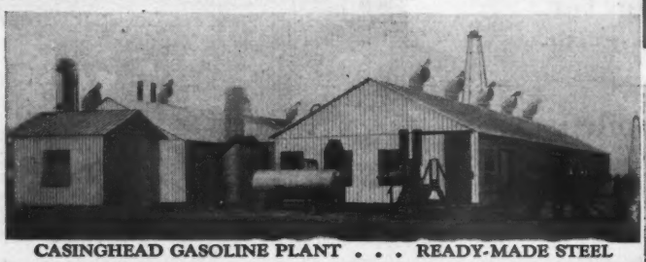
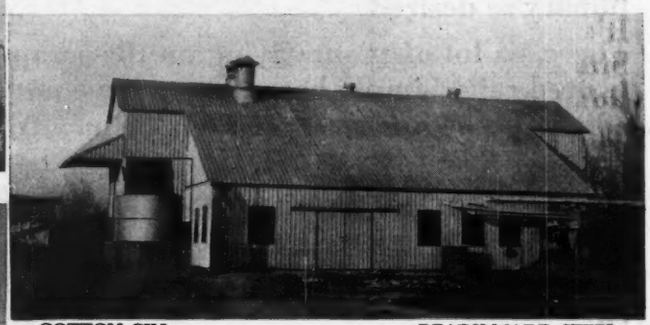


CASINGHEAD GASOLINE PLANT . . . READY-MADE STEEL



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OIL FIELD FLOWING PLANT . . . . . READY-MADE STEEL

In many and varied industrial and commercial undertakings Butler Ready-Made Steel Buildings are solving sheltering problems to the satisfaction of the most exacting engineers. Write for a new booklet showing many of these installations. Then Butler engineers will submit detailed information to aid in making a selection for your particular requirements.

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CP-6

A *Better* Drifter for Hardest Formations

A Worthy Running Mate for the Time-Tested CP-5

DESIGNED and built for the hardest formations, where drilling speed, dependability and low upkeep are of paramount importance, the CP-6 meets the requirements without the handicap of excess weight.

Similar in appearance and running characteristics, its larger bore, 3½ inches, makes it more suitable than the CP-5 for the severer conditions—low upkeep is a "built-in" quality of both sizes.

Although on the market for a comparatively short period, the CP-6 has been adopted by many of the largest mining companies on the North American continent after extended tests.

If you are looking for a *better* drill for your tough ground, try the CP-6 Drifter—under your own conditions —in your own way.

Chicago Pneumatic Tool Company

Sales and Service Branches All Over the World R-135

6 East 44th Street New York, N. Y.

This Dorr Thickener and Dorrco Filter are Making Big Savings!

THE Thickener and Filter illustrated are handling a copper concentrate that formerly was treated in settling boxes. The labor charges for cleaning out these settling boxes were high; considerable fine concentrate was lost in the overflow; and the concentrate shipped to the smelter, where charges were figured on a wet weight basis, was wet and difficult to handle.

The Dorr Thickener and Dorrco Filter have replaced the settling boxes and now dewater the concentrate continuously and automatically. The savings realized through reduced labor charges and lower moisture content of the shipped concentrate have been sufficient to pay for the equipment in a short time. And on top of this there is the added saving of fine concentrate which formerly was lost in the settling box overflow.

Here is another case where modern Dorr equipment and modern methods of wet-material handling are proving to be big money-makers. Perhaps in your plant there is some operation that could be similarly improved on. The experience of our staff is at your disposal. Our engineers will gladly analyze your wet-material handling problems without obligating you in any way.

DORRCO

THE DORR COMPANY

ENGINEERS

247 PARK AVENUE NEW YORK CITY

INVESTIGATION TESTS DESIGN EQUIPMENT

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Societe Dorr et Cie
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JOHANNESBURG, S. A.
E. L. Bateman
Locarno House.

Eliminate Your Coupling Shutdowns!

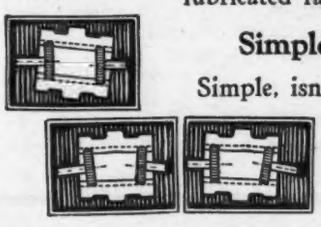
EVERY TIME an old-type flexible coupling fails—trace it and almost invariably it is due to the breaking down of flexible bushings, pins, springs, discs or grids.

No wonder "fatigue of materials" so frequently sets in wherever any material is under constant bending back and forth with each revolution of the shaft. Failure comes, and the drive must be shut down to replace the broken parts.

It Is Not Necessary!

Do you realize that 99% of flexible coupling troubles vanish when you replace flexible materials with the modern FAST'S Self-Aligning Coupling, which provides purely *mechanical* compensation for shaft misalignment?

See the sketch below. A spur gear on each shaft end. A casing, with internal gear teeth to match, slipped over the two gears. As one shaft turns, the casing turns also. The other shaft turns, as a unit with it, the entire misalignment being taken up between the lubricated faces of the gear teeth.



Simple and Effective

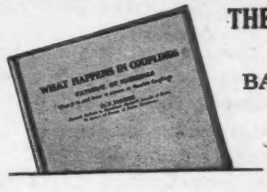
Simple, isn't it? Instead of relying upon flexible pins, bushings, discs or springs to absorb misalignment, no flexible materials are used. There is nothing to fatigue, nothing to be replaced, nothing that may cause a plant shut-down for repairs when you can least afford it.

Like most inventions that have revolutionized time-honored practice, Fast's coupling is so simple that in the ten years since its first development, it has swept the coupling field because of its remarkable performance.

Read Why

If you will mail the coupon, we will send you a bound reprint of the Prof. Moore article, "What Happens in Couplings," that tells the entire story. Learn how flexible materials can be eliminated, so your plant may eliminate flexible coupling failures.

Sign and mail this coupon today to



THE BARTLETT HAYWARD CO.
214 Scott Street
BALTIMORE • MARYLAND

Please send me the free book by Prof. Moore.

*Name*_____

*Firm*_____

*Address*_____

Illustration shows work under construction on the hotel "The New Yorker", located on 8th Avenue, 34th to 35th Streets, New York City, which has been recently completed. Sugerman & Berger, Architects, Lange & Noska, Engineers.

STRUCTURAL STEEL
FOR THIS NEW HOTEL WAS FABRICATED AND FURNISHED BY

AMERICAN BRIDGE COMPANY

Subsidiary of United States Steel Corporation

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"Actually cost much less to use than the wooden blocks they replace,—"

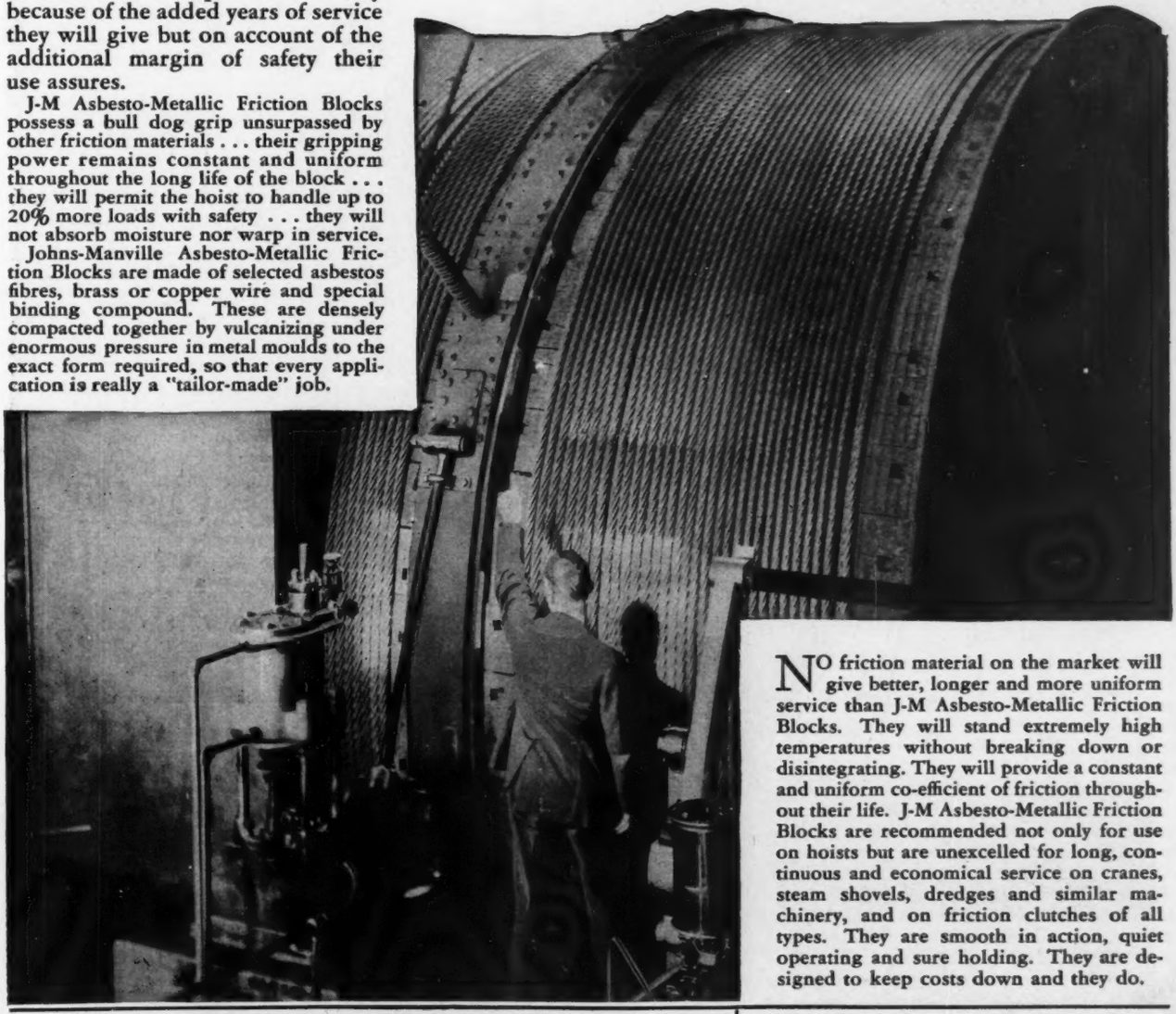
THE mine superintendent who made this statement based his opinion on the performance of a set of J-M Asbesto-Metallic Friction Blocks that had been in use on one of his deep shaft hoists for eight years. These blocks are still in perfect condition and good for several additional years of service. We know of no wooden blocks that have ever given service approaching this.

J-M Friction Blocks are recommended for hoist operation not only because of the added years of service they will give but on account of the additional margin of safety their use assures.

J-M Asbesto-Metallic Friction Blocks possess a bull dog grip unsurpassed by other friction materials . . . their gripping power remains constant and uniform throughout the long life of the block . . . they will permit the hoist to handle up to 20% more loads with safety . . . they will not absorb moisture nor warp in service.

Johns-Manville Asbesto-Metallic Friction Blocks are made of selected asbestos fibres, brass or copper wire and special binding compound. These are densely compacted together by vulcanizing under enormous pressure in metal moulds to the exact form required, so that every application is really a "tailor-made" job.

Johns-Manville ASBESTO-METALLIC FRICTION BLOCKS



NO friction material on the market will give better, longer and more uniform service than J-M Asbesto-Metallic Friction Blocks. They will stand extremely high temperatures without breaking down or disintegrating. They will provide a constant and uniform co-efficient of friction throughout their life. J-M Asbesto-Metallic Friction Blocks are recommended not only for use on hoists but are unexcelled for long, continuous and economical service on cranes, steam shovels, dredges and similar machinery, and on friction clutches of all types. They are smooth in action, quiet operating and sure holding. They are designed to keep costs down and they do.

JM PRODUCT

Johns-Manville

Asbesto-Metallic FRICTION BLOCKS

JOHNS-MANVILLE CORPORATION
New York Chicago Cleveland San Francisco Toronto
(Branches in all large cities)

Please send us further information about Asbesto-Metallic Friction Blocks.

Name.....

Company.....

FB-84-1

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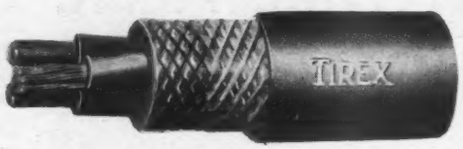
Where Production is Heaviest

TIREX

is generally the cable specified



The giant electric shovel pictured below handles more than 8,819 cu. yd. of overburden per 8-hour shift. It has a 12-cu. yd. bucket, 54-ft. dipper handle, 85-ft. boom and weighs 700 tons. The motive power is a 435-kva. 4000-volt synchronous motor driving three direct current generators all on the same shaft.

TIREX, the cable selected to carry power to this shovel was chosen because of its ability to give long, trouble-free service under both favorable and unfavorable working conditions.

All TIREX Cables are protected by a "selenium rubber" outer jacket, the toughest, most wear-resisting rubber compound made. Write for further information.

SIMPLEX WIRE & CABLE Co

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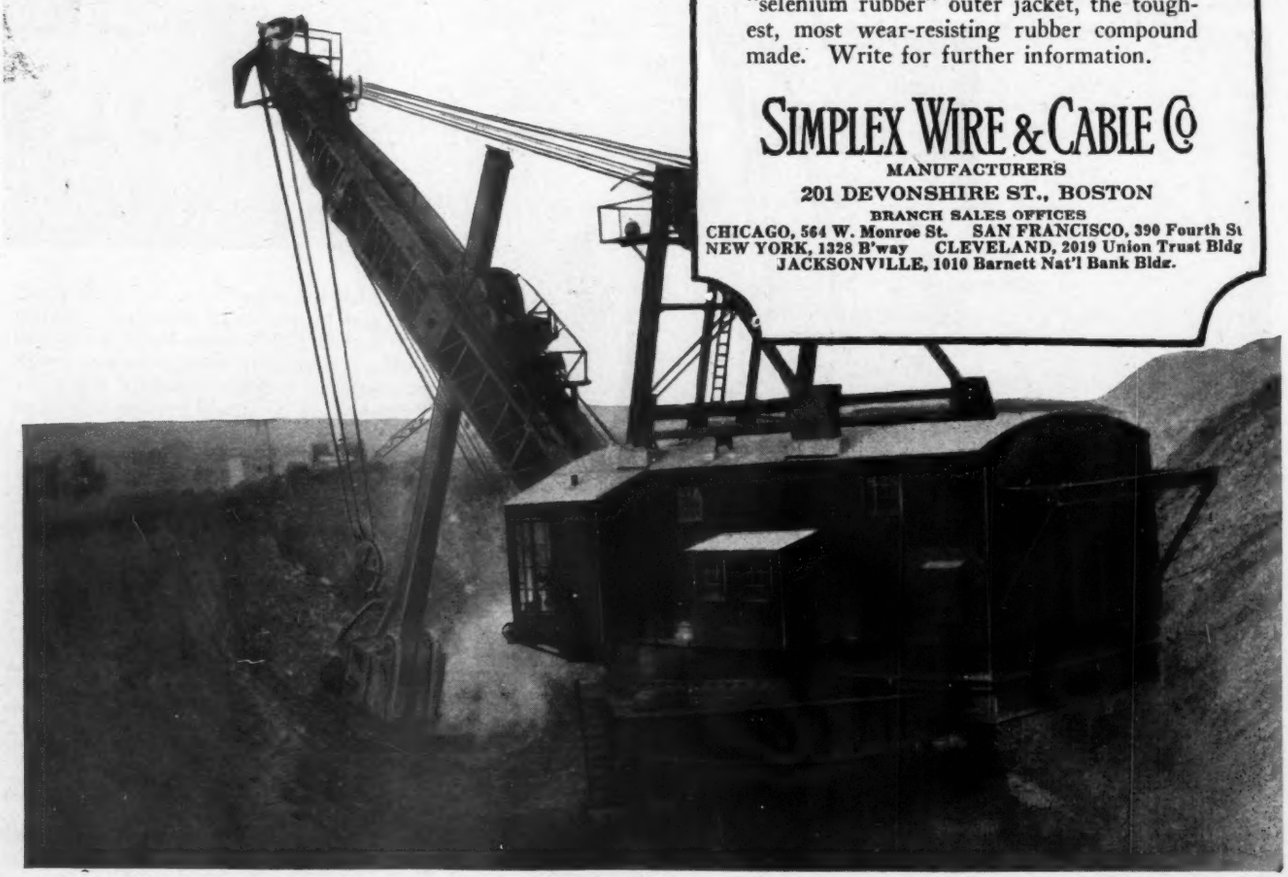

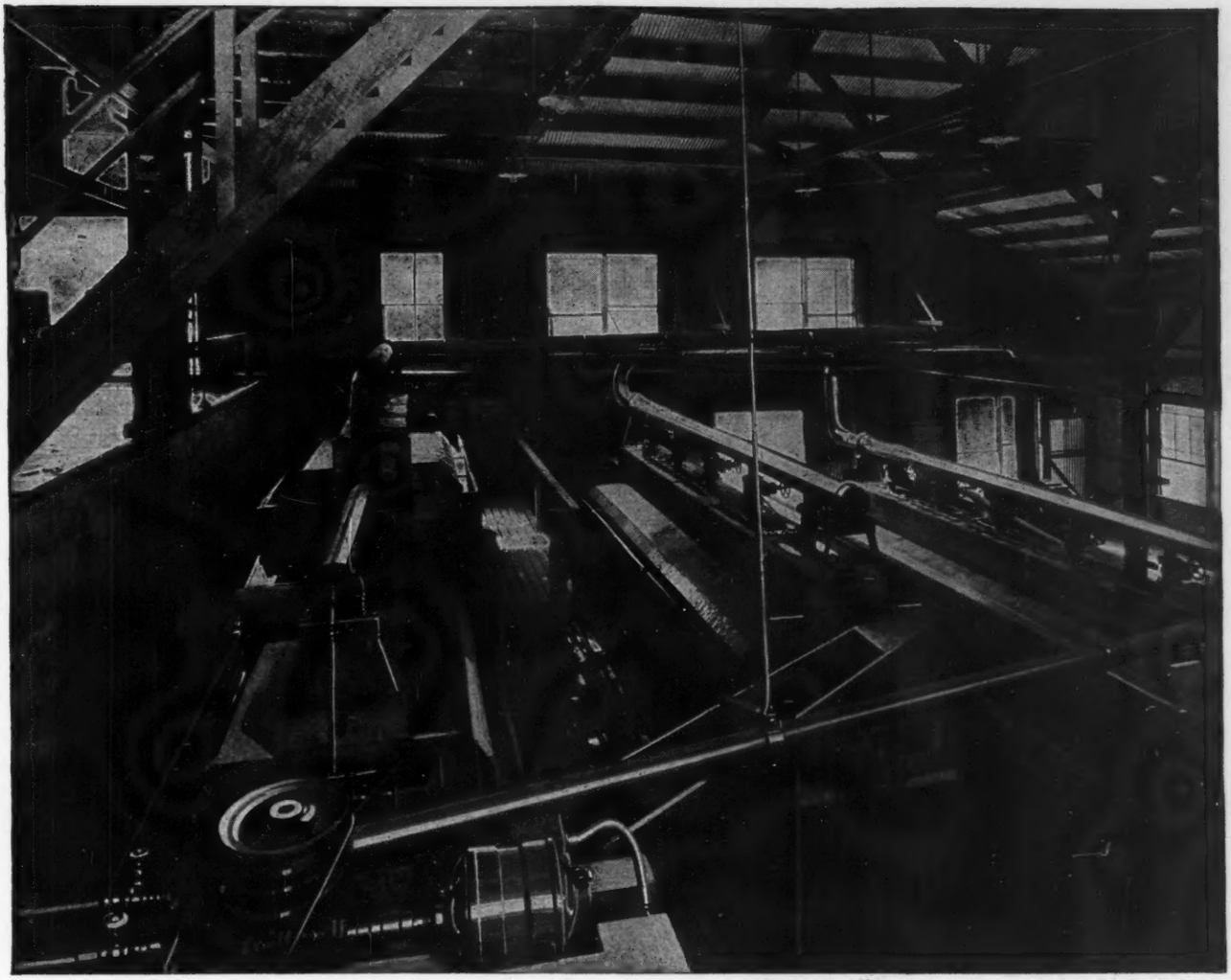

INCREASING RAPIDLY

Over 60,000 tons of ore are now being treated daily with air-lift type flotation machines. Southwestern engineers are putting in many experimental installations for the larger mining companies.

Here are the reasons—*low maintenance, lower operating costs and positive metallurgical efficiency.*

Get in touch with our engineers for detailed information. Write now.

Our new bulletin No. 1240 on air lift flotation is now ready.

SOUTHWESTERN ENGINEERING CORPORATION

NEW YORK, N. Y., 117 Liberty St.
TULSA, OKLA., Mayo Bldg.

606 South Hill Street
LOS ANGELES, CALIF.

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Southwestern Equipment and Service:

Factory-Built Mills—25 to 50 tons
Southwestern Matless Flotation Machines, Air Lift Type
Dry and Liquid Reagent Feeders

K & K Flotation Machines Horizontal Rotor Type
Southwestern Littlewood Sand Pumps
Southwestern-Butler Vacuum Filters

Ore and Pulp Samplers
Ore Feeders
Water Tube Boilers
Ore Testing, Mill Design, Erection

TRANSFORMED

an antiquated mine into a profitable modern producer

The advantages to a mining company in utilizing the services of Gould engineers are shown in the results obtained at Oceanic Mine. This quicksilver property is located in San Luis Obispo County, Calif. For many years it was operated in an intermittent way. Methods and equipment were not in keeping with present day successful practices.

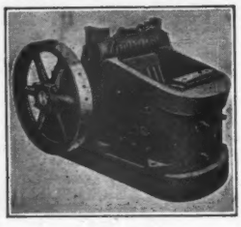
H. W. Gould & Co. were called in. They were asked to put the property on a paying basis. With their staff of experienced engineers, metallurgists and specialists on mine and mill management suitable modern equipment was installed—operations carefully and efficiently conducted. Today Oceanic is a real producer. And Oceanic is only one of many properties the Gould organization has put on their feet.

Regardless of size or location, this organization will undertake to successfully develop, operate and manage any property.

H. W. GOULD & CO., Mills Buildings, San Francisco, Calif.

Mining and Metallurgical Engineers—Specialists in Mine and Mill Management

a little picture



of a BIG PRODUCER

TRAYLOR BULLDOG JAW CRUSHER

FOR INSTANCE

36″x48″
Bethlehem Mines Corp.
Cornwall, Pa.

Chateaugay Ore & Iron Co. (2)
Lyon Mountain, N. Y.

Homestake Mining Co. (3)
Lead, S. D.

42″x48″
Wharton Steel Co.
Ogdensburg, N. J.

48″x60″
Bethlehem Mines Corp.
Steelton, Pa.

56″x72″
Bethlehem Mines Corp.
Cornwall, Pa.

And the users' side of the picture—the side you're interested in—is given by that partial list to the left. And a few of the reasons behind the success of this crusher are:

(1) The power-saving PITMAN, of great strength yet minimum weight; (2) the frictionless 3-bearing toggle system; (3) self-aligning bearings; (4) general accessibility of all parts.

Bulletin 2099—if you want details of Traylor Bulldog Jaw Crushers. Send for a copy today.

TRAYLOR ENGINEERING AND MANUFACTURING CO.
ALLENTOWN, PENNA.

New York City, 30 Church St. | Chicago, 1414 Fisher Bldg. | Los Angeles, 908-909 Chester Williams Bldg. | Seattle, 815 Alaska Bldg. | Salt Lake City, 101 W. 2nd So. St.

EXPORT—104 Pearl Street, New York City

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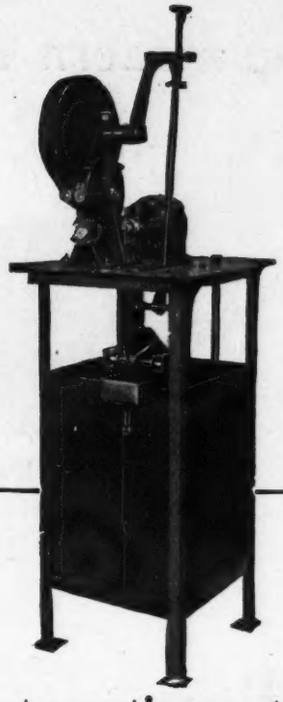

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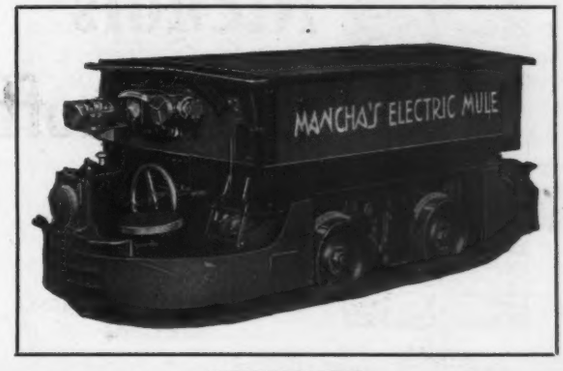

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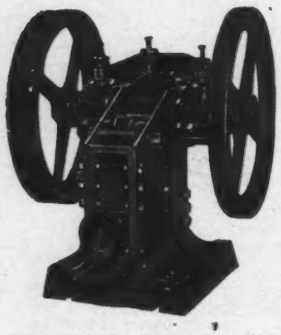

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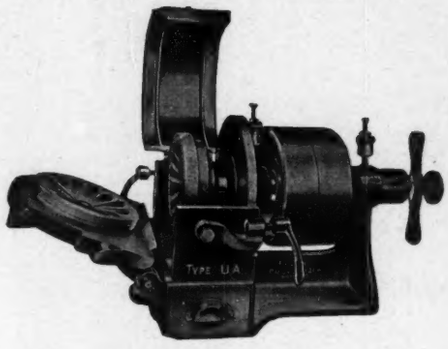

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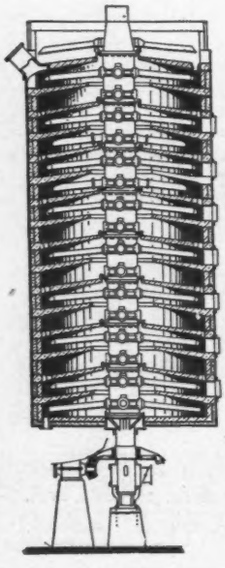

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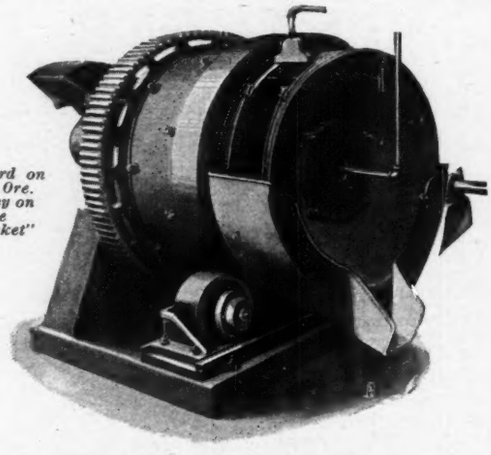

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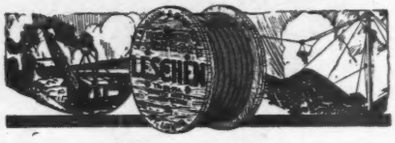

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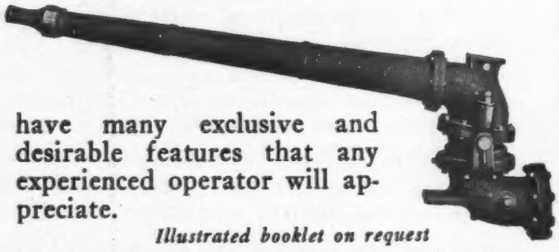

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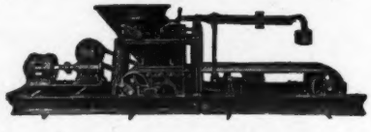

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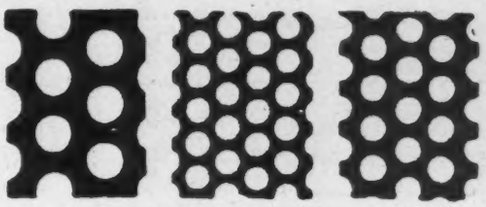

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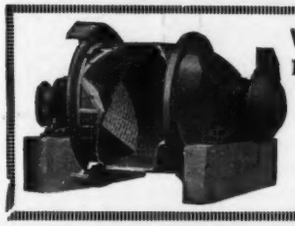

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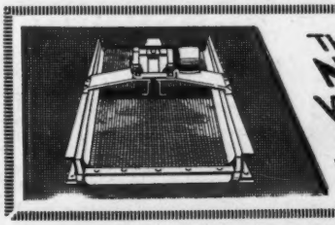

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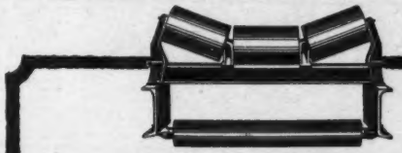

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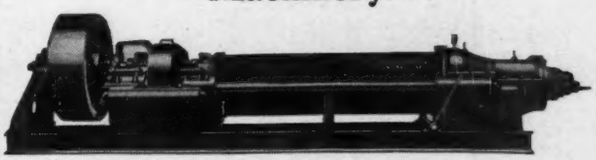

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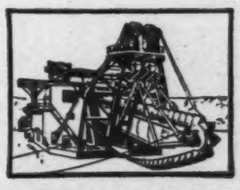

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ALPHABETICAL INDEX TO ADVERTISERS

This index is published as a convenience to the reader. Every care is taken to make it accurate. but *Engineering and Mining Journal* assumes no responsibility for errors or omissions.

	Page
Abendroth & Root Mfg. Co.	38
Allis-Chalmers Mfg. Co.	4
Alloys Co.	32
American Bridge Co.	20
American Metal Co., Ltd.	31
American Smelting & Refining Co.	29
American Steel & Wire Co.	14
Atlas Car & Mfg. Co., The	32
Baker & Co., Inc.	29
Bartlett Hayward Co., The	19
Bedford & Sons, Ltd. J.	39
Bethlehem Foundry & Machine Co.	32
Bishop & Co., Platinum Works, J.	30
Braun Corporation, The	26
Braun-Knecht-Heimann Co.	26
Bristol Co., The	12
Bullard Davis, Inc.	40
Butler Mfg. Co.	16
Chicago Perforating Co.	37
Chicago Pneumatic Tool Co.	17
Cleveland Rock Drill Co.	32
Colorado Iron Works	56
Continental Diamond Drilling Co., Ltd.	33
Coppus Engineering Corp.	28
Crucible Steel Co. of America	7
Custodis Chimney Const. Co.	39
Deister Concentrator Co.	37
Deister Machine Co.	38
Diamond Drill Carbon Co.	40
Dings Magnetic Separator Co.	37
Dobbins Core Drill Co.	32
Dodge Mfg. Corp.	37
Dorr Co., The	18
Dust Recovering & Conveying Co.	32
Electro Metallurgical Sales Corp.	10
Elliott Co.	37
Engineers Exploration Syndicate, Inc.	33
Fairfield Engineering Co.	3
Filter Fabrics Co., The	40
Freese & Co., E. M.	39
Galigher Co., The	25
Gardner Denver Co.	9
General Engineering Co.	IV Cover
General Naval Stores Co.	30
Georgia Iron Works	28
Gould & Co., H. W.	24
Great Western Electro Chemical Co.	32
Harbison Walker Refractories Co.	32
Hardinge Co.	37
Harrington & King Perforating Co., The	37
Hendrick Mfg. Co.	38
Ingersoll Rand Co.	II Cover
International Smelting Co.	30
Irvington Smelting & Refining Works	29
Johns-Manville Corp.	21
Keystone Test Driller Co.	32
Ledoux & Co., Inc.	33
Leschen & Sons Rope Co., A.	28
Magnetic Mfg. Co.	37
Mancha Storage Battery Locomotive Co.	25
Matthieson-Hegeler Zinc Co.	30
McGraw-Hill Book Co.	27
Merco Nordstrom Valve Co.	32
Merrill Co., The	32
New York Engineering Co.	32
Nichols Copper Co.	26
Ohio Brass Company, The	38
Oliver United Filters Inc.	37
Oxweld Acetylene Co.	13
Pacific Foundry Co.	26
Pacific Tank & Pipe Co.	28
Phelps-Dodge Sales Co., Inc.	30
Plymouth Locomotive Works	38
Post-Glover Electric Co.	37
Roots Co., The P. H. & F. M.	32
Ross Screen & Feeder Co., The	8
Ryerson & Sons, Inc., Jos. T.	37
Schaffer Poidometer Co.	28
Shriver & Co., T.	37
Simplex Wire & Cable Co.	22
Smith Engineering Works	32
Southwestern Engineering Corporation	23
Stephens-Adamson Mfg. Co.	11
Stoody Co.	27
Straub Mfg. Co.	26
Sullivan Machinery Co.	5
Swedish American Prospecting Corp.	33
Taylor Forge & Pipe Works	37
Technical & Industrial Service Section	33
Traylor Engineering & Mfg. Co.	24
United Metals Selling Co.	30
United States Smelting, Refining and Mining Co.	31
Vulcan Iron Works	28
Watt Car & Wheel Co., The	15
What and Where to Buy	36, 38
Wellman-Seaver-Morgan Co.	37
Western Precipitation Co.	32
Wiederholdt Construction Co.	32
Williamson Co.	37
Worthington Pump & Mach'y Corp.	6
Yuba Manufacturing Co.	39

SEARCHLIGHT SECTION

Classified Advertising

Classification	Page
BUSINESS OPPORTUNITIES	34
EMPLOYMENT SERVICE	34
FINANCING	34
POSITIONS VACANT	34
POSITIONS WANTED	34
USED AND SURPLUS EQUIPMENT	34
Consolidated Products Co.	34
Eastern Iron & Metal Co.	35
Heineken Eng. Corp.	34
Kehoe, Robt. P.	35
Knapp Co., J. E.	35
Miller, H. M. A.	34
Mines Supply & Machy. Co.	35
Morse Bros. Mach. & Supply Co.	35
Royal Tiger Mines Co., The	35
Stein Brill	34
Western Machy. Co.	35

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In one mine, no one miner, manager or visitor —is allowed to go underground without a Hard Boiled Hat. The reason is that they reduce head accidents.

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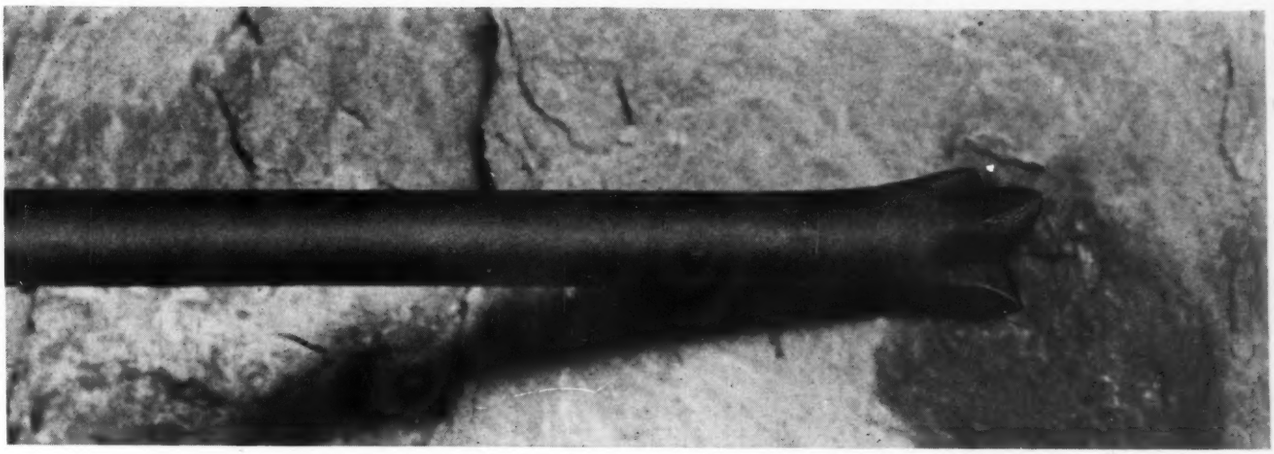
The Hard Boiled Hat is made by a patented process to give head protection. It is sturdy, a non-conductor of electricity, acid and waterproof.

A small item *with a big influence on mining costs*



IN the total cost of mining operations drill steel is a very small item *but* it holds a position of such importance that its selection is a matter worth the most careful consideration.

If the drill steel used suffers fatigue and breaks frequently or does not hold its cutting edge, the expense of replacing or repointing drills together with the value of the time lost from interruption of operations will amount to a sum far greater than the slight additional cost of the best drill steel obtainable.

Bethlehem Superior Hollow Drill Steel has proved its worth by its remarkable performance in many mines and quarries under the most severe conditions. The Bethlehem Tool Steel Plant in which this steel is made is a separate, completely-equipped unit devoted solely to the production of tool steels. To the men responsible for the quality of Bethlehem Tool Steels the making of fine tool steels is second nature.

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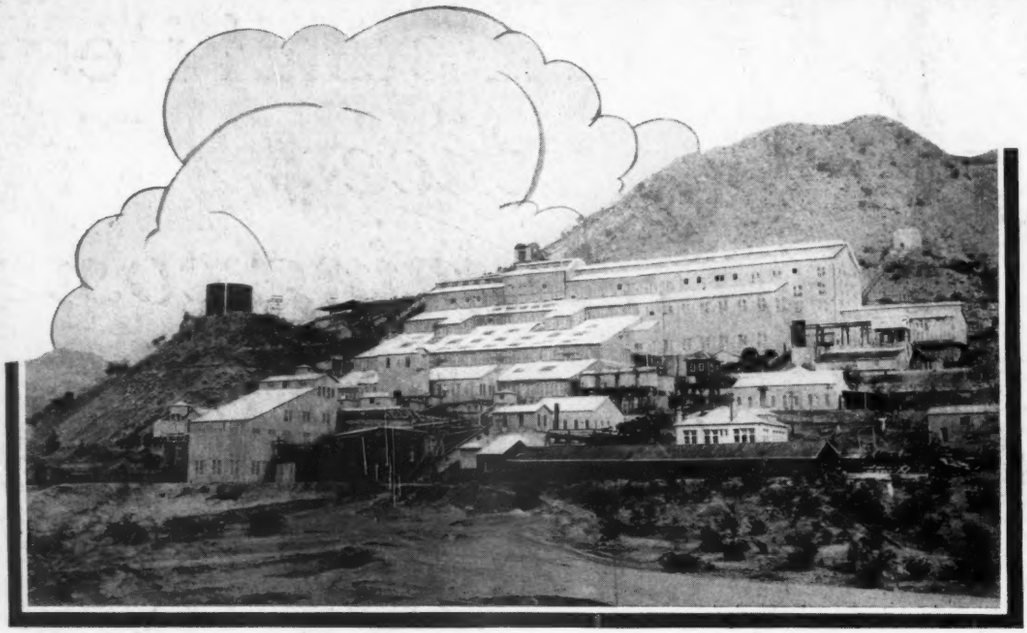

This is not the plant referred to below, but is another MacIntosh plant (Nacozari Concentration, of the Phelps-Dodge Corp.), where 3,000 tons per day is floated in MacIntosh Machines.

Often it PAYS to replace with MacIntosh Flotation Machines

A case in point is a large copper concentrating plant in Arizona.

After several months' trial in one unit of the plant, MacIntosh machines were installed to replace those previously used.

When the reconstruction program is completed, this plant will have a daily capacity in excess of 10,000 tons.

If interested, we shall be glad to give you further details of this installation, and will also send you a copy of the latest MacIntosh bulletin.

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